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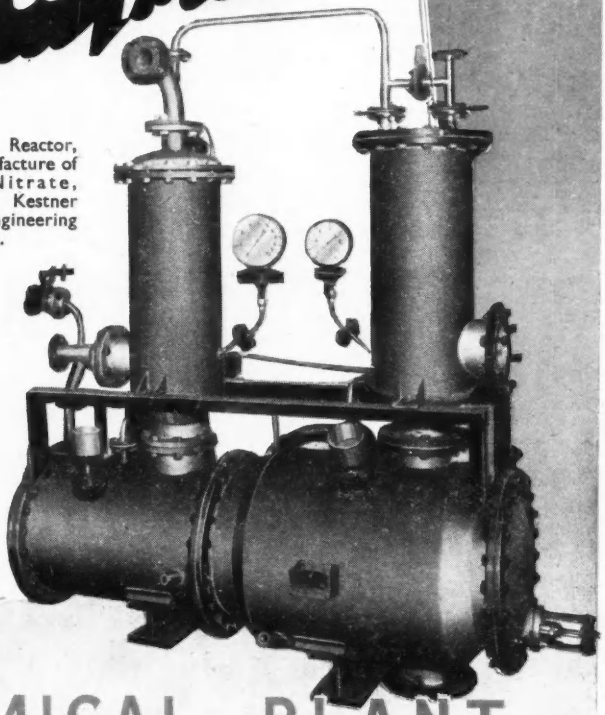

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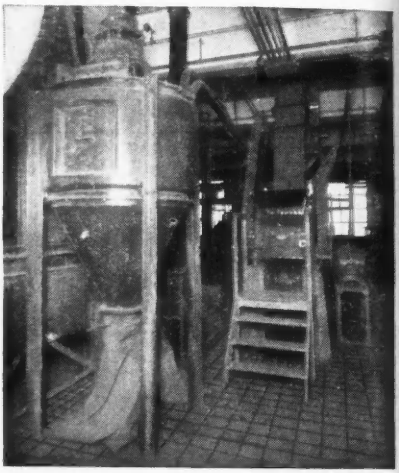

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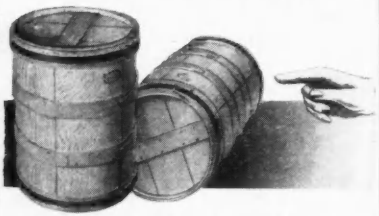

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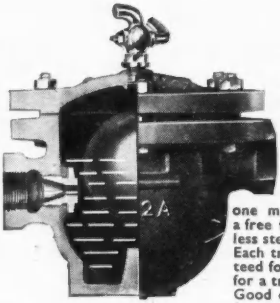

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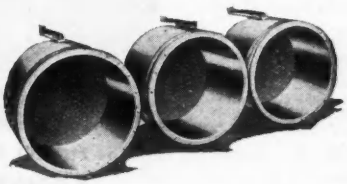

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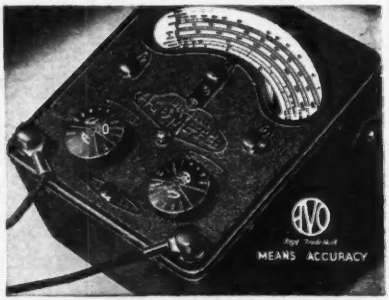

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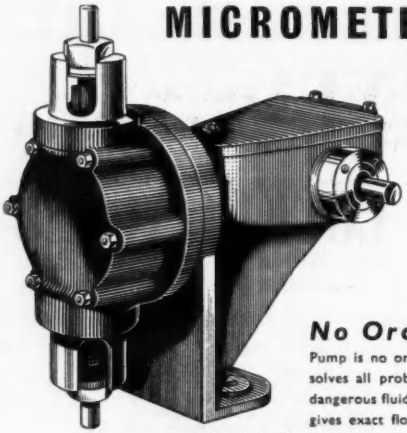

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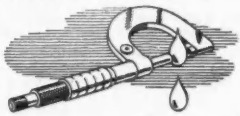

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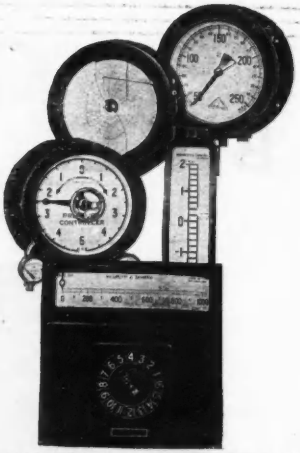

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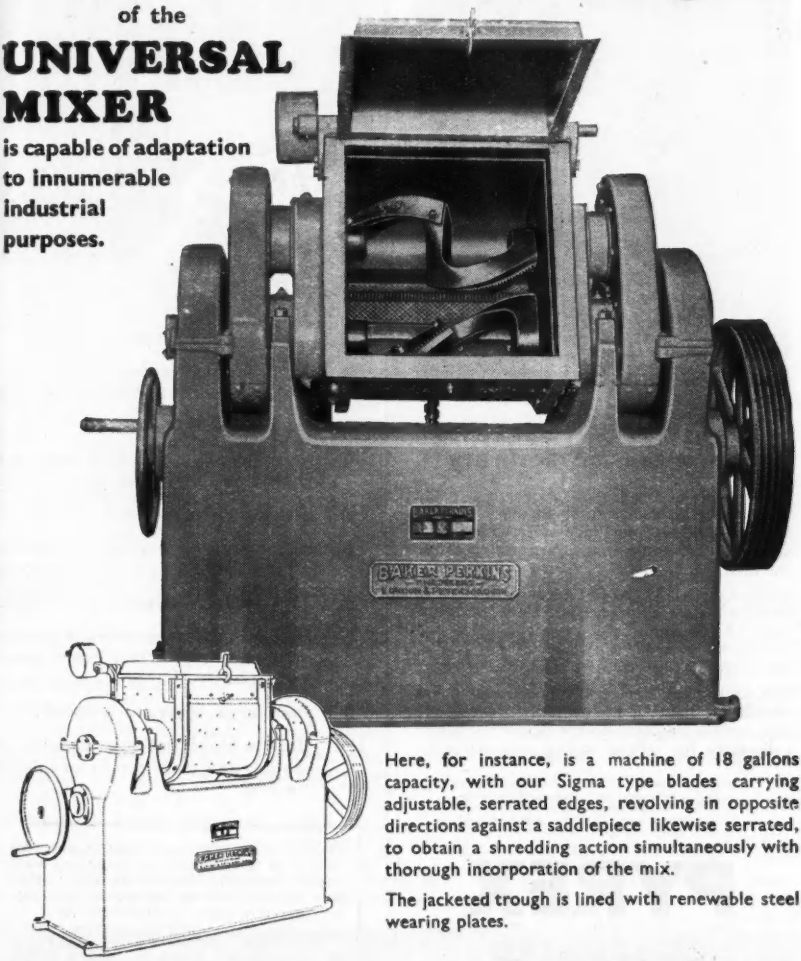

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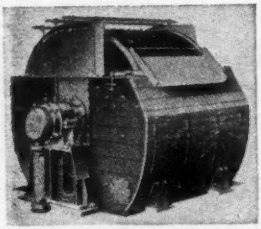

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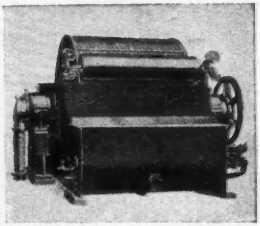

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Scottish Mineral Resources

INDUSTRY and industrial production depend largely upon the availability of raw materials. Raw materials may be acquired from without, but in that event the profit to the nation from its manufactures will be less than when the raw material is produced at home. Moreover, the raw materials are not under the direction of the producer and difficulties may be placed in the way of importing whatever is necessary to maintain industry in full production. This disability does not seem to matter in certan industries, such as cotton, in which we have acquired such specialised skill that other nations readily buy our goods and are pleased to send us their raw materials to be made into the finished article. That type of manufacture, however, is at best precarious. The nations that grow cotton may one day decide that they will do their own manufacturing and we shall find ourselves so handicapped that our cotton industry may die. There is no likelihood of that happening just now, so far as we can see, but the possibility indicates how much more important it is to possess one's own raw materials than to be dependent upon the foreigner for them. It occurs to us to wonder how far we are well informed about the raw materials that these islands possess. It has been stated that the Geological Survey has learnt a great deal from the recent boring for petroleum, boring that has gone deeper than is customary when prospecting for coal. The cost of boring holes in the ground to any depth is considerable, but would it not be of value to place reasonable sums at the disposal of the Geological Surey to enable the necessary information to be acquired?

The two most important raw materials for chemical manufacture are water and air; there is no doubt that these islands possess both of those materials in superabundant supply. Scarcely less important is coal, or if not coal then a source of heat and power such as water-power. Sulphur is the next in importance and then follow at a respectful interval mineral salt (NaCl) and limestone. A long gap separates these in importance from sulphide ores, brines and petroleum, natural gas and saltpetre. After this come all the various and sundry metallic ores, highly important in themselves, but relatively infrequent in use. The order of the minerals and other raw materials would be quite different, of course, for industries other than that of chemical manufacture. For iron and steel manufacture coal and iron ore would be bracketed equal first,

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with limestone, fireclay and silica rock of almost parallel importance. The rare alloying elements would be a long way down the list. To be sure, iron ore and coal can both be imported, as yet, and both are imported by many countries to feed their own iron and steel works. Such countries as import the whole of their steel-making materials, however, could not expect to produce steel for export; the test of British economics in respect of the availablity of any raw material is primarily whether by its use goods can be made for export. All this goes to show that the only sound way to plan the national industry is to ascertain exactly what raw materials are available and put them to the best possible use.

These considerations caused us to be interested in a paper recently delivered in Glasgow by Dr. Murray MacGregor dealing with the mineral resources of Scotland. He did not need to mention air and water for the reason we have stated. Scottish coal supplies give some cause for alarm, but the quantity available is sufficient for at least a couple of centuries of normal industrial development. If Scotland were to be much more highly industrialised, the period of time during which it could remain an industrial nation would be reduced if it were to be solely dependent on its own coal reserves. Much of the Scottish coal has already been mined; the rich coalfield of Clyde Valley is approaching exhaustion; in Stirlingshire, West Lothian, and Central Fife large inroads have been made. There are, however, large reserves still to be found in East Fife, Midlothian, West Fife, Clackmannan, and in Central Ayrshire. Estimated reserves in 1944 were 3438 million tons plus 4214 million tons which are likely to be present but are still unproved.

At the present rate of 30 million tons of coal mined a year, and if all the coal were extracted from the ground, the possible limit of time during which Scotland could maintain her industries at her present rate would be 250 years. But not all the coal is brought to the surface and a proportion is lost in cleaning. Even at the present rate, Scottish coal may well be exhausted in 150 years for all practical purposes. If any considerable further industrial developments take place in Scotland, the period would be proportionately shorter, unless coal were brought from England or some other source of fuel were found. It is here that water comes in; hydro-electric power will assist materially, and must clearly be encouraged to the full. So far as is known, however, the available hydro-electric power, even in Scotland, is but a small proportion of the total energy needed.

There are in addition, however, some 2 million acres covered with peat of more than 2-ft. thickness. The utilisation of peat is one of the most important problems facing many countries, Scotland among them. Dr. MacGregor points out that renewed attention has been given within recent years to the potential uses of peat in various industries. A more detailed knowledge of the larger and more accessible mosses, their extent, thickness and vegetational variations would seem, accordingly, essential to a proper estimation of their economic value. Scotland appears to have no sulphur or salt. Nevertheless, there might well be the possibility, to put it no higher, of recovering sufficient sulphur from coal in the form of fairly concentrated pyrites from cleaning plants, from the hydrogen sulphide generated when coal is carbonised, and from the sulphur dioxide generated when coal is burnt. Do we go to sufficient lengths in the recovery of our raw materials? It is now common knowledge that we have squandered our coal reserves for 150 years because coal was cheap; we have just awakened to that fact. Are we similarly squandering our other mineral resources, and shall we awaken to that fact also when it is too late? Is it not possible that sulphur could be recovered economically from coke-oven gas? Is it not possible that an economic process could be devised for producing sulphur or highly concentrated pyrites from coal washery refuse? This country could be self-supporting in sulphur; would it be a good thing to encourage it to be so by Government action? Such action could be devised without adding to the cost of making sulphuric acid. Once we got started on a projected home market, there is no knowing how soon scientific development might enable the preference to be removed. At least it would keep our money at home.

Scotland has plenty of limestone and it is widely distributed. There are also immense supplies of dolomite available in the North-West Highlands. This material is the only British source of magnesia and is important as a basic refractory, and in the manufacture of magnesium metal, besides finding uses in the chemical indus-

try and as a flux in steel-making. Scotland has its own peculiar range of oil shales which occur locally and have been the basis of the shale oil industry with which the name of James Young will ever be associated; he it was who succeeded in creating a large shale oil industry in Scotland, building his first refinery just over 100 years ago. In 1913 the production of oil shale was 3¼ million tons, but in the inter-war years it fell to 1½ million tons; there are still large reserves of oil shale though, in Dr. MacGregor's view, the 1917 estimate of 500 million tons must be reduced considerably. Now, of course, the search for petroleum has begun and small quantities of petroleum accompanied by quite large quantities of natural gas have been found. The difficulty of making use of natural gas for chemical manufacture is that one never knows when the supply will cease; it is something of a gamble unless there is an alternative material to which the plant could be turned if the gas supply should fail. Refractory clays, so necessary for many industries, are present in abundance together with many other argillaceous and arenaceous materials; but do we know all there is to be known about the minerals and other raw materials present in so disturbed a geological area as the Highlands of Scotland?

Dr. MacGregor's summary is that "Scotland possess ample reserves of coal sufficient to meet her needs for a long time (this depends on what one means by 'a long time'); there are ample reserves of high-quality refractory clays, immense reserves of limestone and large virgin reserves of oil shale. Large supplies of constructional and building materials of every kind, silica rocks, ganisters and sandstones, materials for the refractory, glass-making, chemical, steel-making and casting industries are available, and there are vast reserves of peat. The immense deposits of dolomite and quartzite in the Highlands are practically untouched, and there are large reserves of water-power untapped. But more should be known, not only about our raw materials, but about their potential uses. There is no place in Scotland where tests and research investigations can be carried out on materials other than coal."

NOTES AND COMMENTS

A GREAT FRENCHMAN

IN the history of chemistry and physics many of the greatest names belong to France, and yet another illustrious addition to an already brilliant constellation is now to be recorded under the name of Andre Helbronner, who died in the German concentration camp, Buchenwald, in 1944, at the age of 66. He was arrested in 1943 when attempting to fly to London, and, refusing the German "invitation" to work for them, was deported to Buchenwald. The record of his achievements is impressive. Already in 1932 he had interested himself in nuclear physics, and despite the inadequate equipment at his disposal he anticipated many of the ideas current in 1939-43. In October, 1939, he suggested the use of heavy water for atomic bombs. Indeed in some respects he appears to have been in advance of the state of knowledge disclosed in the Smythe report. He was only a young man in the early twenties when he anticipated some of the ideas of Linde and Claude in regard to rectification of liquid air. His first patents, in fact, date from 1901, and his oxygen and nitrogen liquefaction plant was still among the most efficient in 1924. Among his many contributions to chemical and physical science it is only possible here to note some of the more outstanding successes. These include: colloidal metal suspensions in organic liquids, of great value in pharmacological technique; the mercury-quartz vapour lamp; ultra-violet ray work and rubber research; wood distillation and methyl acetate production; electrolytic production of chromates. These alone would indicate something of the range of a brilliant and versatile mind; but there is much more. For example, in 1917 the fuel problem in France was nearly as acute as now. Helbronner devised a new method of concentrating sulphuric acid whereby coal consumption per ton was reduced from 500 to 87 kilos. This, however, was not protected by patents, and about 1920 was "re-invented" and used in Germany. He received the medal of the Franklin Institute about 1923. Just before the war he was collaborating in the

invention of an electrical device for automatic control of machine tools. A final tribute to him in *Chimie et Industrie*, makes a fitting epitaph :—" Savant modeste, il aima la science pour elle-même et refusa toujours les consécrations officielles et tous les honneurs qui lui furent offerts."

NATIONAL BALANCE SHEET

EVIDENCE that the British chemical industry is stabilising its position in the markets of the world is provided by the newly-issued *Trade and Navigation Accounts of the U.K.* for 1946. In this itemised record of import and export transactions in chemicals, and in many basic metals, a substantial balance in our favour is shown. Knowledge of the many hampering influences with which industrialists have had to contend since the last year of the war, among which labour conditions, plant shortages and some uncertainty about supplies and shipping have ranked high, renders the achievement all the more creditable; and it is noteworthy that similar export surpluses have not been achieved by many comparable industries. The general reduction in chemical imports since 1945—with the understandable exception of the fertiliser group—is perhaps a subject for less congratulation, welcome though it undoubtedly is from the standpoint of national finances. Although in many cases these reduced imports may reflect Britain's greater level of self-sufficiency, stringency of foreign currency and the slow recovery of overseas producing areas have doubtless been contributing factors, and where some basic chemicals are concerned larger imports might have had a tonic effect. Whether this first substantial step towards pre-war conditions in the chemical industry can be repeated when the 1947 figures come to be published will depend on several factors, among which a successful solution to the present coal shortage is one of immediate urgency.

COAL AND CHEMICALS

OVERSHADOWING all other topics in chemical manufacture and its ancillary industries this week is the problem of keeping plants running at an economic level on coal supplies grossly inadequate to the contemporary need of higher production, and barely sufficient for minimum activity. At least one chemical firm in Scotland is reported to be on half production and it is clear this is no isolated case. Short time will be worked in the iron and steel works and in several other industries. The effect of the new coal allocations, involving in most cases a 50 per cent cut, would be, it was hoped, to eliminate uncertainty and put coal distribution on a realistic basis in relation to supplies. This it seems to have achieved, but in most cases at the cost of a very real cut in the amount of fuel on which works can budget. With all due allowance for the fact that it is an emergency measure, the new rationing system is less realistic than was hoped and does not promise to distribute evenly the general hardship of diminishing coal stocks. One evident injustice is that the new allocations, based on the 1946 consumption, penalise, in effect, progressive firms which have been saving coal by fuel economy measures. Extravagant users who now put their house in order will proportionally be the better supplied. And on some undertakings, such as chemical plant manufacturers whose suppliers are themselves handicapped by the coal cuts, the hardship is two-fold. These are only some of the urgent reasons why what was introduced as an emergency measure must not be allowed to become a long-term policy.

Hampered by fumes given off by a 90 ft. by 60 ft. lake of highly-concentrated sulphuric acid escaping from a large tank, firemen had to don breathing apparatus in fighting a fire on January 21 at the premises of the Geigy Colour Co., dyestuff manufacturers, Tenex Road, Trafford Park. Though the fire was put out quickly, firemen struggled for four hours spraying the acid with fine nozzles, as a direct jet would probably have splashed the acid, and caused further fires.

B. Laporte, Ltd., chemical manufacturers, Luton, announce the intention to establish a factory for the manufacture of hydrogen peroxide and peroxide compounds on a 16-acre site at Lower Walton, Warrington. The capital cost of the programme immediately envisaged by the firm is about £500,000, but it is unlikely that the plant can get into production in less than two years. Warrington is regarded as an almost ideal distributing centre for hydrogen peroxide, so extensively used in textile and other industries.

PROGRESS IN DRUGS AND FINE CHEMICALS—II*

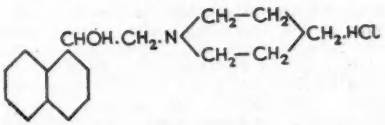
By G. COLMAN GREEN, B.Sc., F.R.I.C., A.M.I.Chem.E.

FOLLOWING the loss to the enemy in 1941 of the producing areas of natural quinine alkaloids and in the light of the necessity of carrying military operations into malarious areas of the world it became necessary to survey and muster all existing sources of supply. The main developments have taken three courses. First, alternative supplies of natural cinchona alkaloids have been exploited. Second, large-scale production of the synthetic anti-malarial drugs which had been developed prior to the outbreak of war in Germany was undertaken. The principal drugs in question were mepacrine (atebrin) and pamaquin (plasmoquin) and for reasons which will be discussed later the former is to be regarded as of greater importance. Third, a search for new synthetic antimalarials was undertaken.

Alternative Sources

The organisation of alternative sources of natural cinchona alkaloids was almost entirely restricted to the South American continent where cinchona trees are indigenous and, indeed, originated. Since the plantations were negligible in number and operated under the auspices of the various governments, the principal sources was wild trees. Problems of communication, transport and low bark yields, therefore, presented themselves. The facilities which, over a period of years, had contributed so much to the wealth of the Netherlands East Indies, such as the plantation system of using carefully bred high-yielding varieties and the close juxtaposition of processing and administrative functions, were quite absent in South America. Moreover, the trend of recent decades has been to plant varieties of cinchona (e.g., *C. Ledgeriana*) in the plantations which gave a high ratio of the more valuable quinine to total alkaloids in the bark. The removal of the bulk of the quinine from the total alkaloids left a residue of alkaloids which was known as "Totaquine" and this, together with the total alkaloids from varieties yielding a low quinine/total alkaloids ratio were available to malarious and economically depressed populations. Circumstances were such that it was necessary to remain content with a "Totaquine" preparation from the South American bark and in this connection it was fortunately demonstrated (*J. Amer. Pharm. Ass.*, 1946, No. 2) that any one of the quinine alkaloids was equally as effective as quinine which, it is claimed, places the use of "Totaquine" on a rational basis. Gallant attempts were made to exploit the South American source and a portable plant was devised for extracting "Totaquine" on the spot. It made use of a base exchange process which was referred to in last year's Review.

Quinidine, an optical isomer of quinine and one of the alkaloids present in totaquine has been isolated by Sanders and Dawson (*J. Amer. Med. Ass.*, 1932, *99*, 1773) by removal of quinine from the total alkaloids extracted from cinchona bark by crystallisation. Cinchonine is precipitated with ammonia and removed. The addition of soda precipitates quinidine. Quinidine has been found to be equally as effective as quinine in controlling malarial symptoms and has been particularly effective in cases of quinine sensitivity; but, generally speaking, it has been little used in treating malaria. Its principal use has been in the treatment of auricular fibrillation, one of the serious heart irregularities. The shortage of quinidine in recent years has promoted a search for alternative drugs for the control of this condition. Dawes (*Br. Med. Journ.* 1946, 43) has explored among the local anaesthetics and spasmolytics in common use, pethidine, piperidine and more complex variants of the quinuclidine structure. 2-α-naphthyl-2-hydroxyethyl-piperidine hydrochloride was found to be the most promising substance examined having an activity two to eight times that of quinidine.



The life-cycle of the malaria parasite requires two hosts—a man and a mosquito of the *Anopheles* species. The sexual part of the life-cycle is completed in the mosquito; but the asexual part of the cycle is carried out in man, the intermediate host. Infection is carried to man through a bite of a female mosquito of the species which seeks a blood-meal prior to oviposition. During the blood-meal a sporozite form is injected into the blood-stream of the host. From this point on the host is malarious although clinical symptoms do not make themselves apparent until some time later. The sporozites are thought to invade the tissues whence the parasite is periodically released

* The first part of this review appeared in our issue of 11 January, 1947, pp. 72-76.

into the blood stream, thence to invade and develop in the blood cells until they burst to release the asexual schizont form into the blood stream to the accompaniment of the characteristic malarious chills and fevers some 9-15 days after the infection has been contracted. After the clinical symptoms have subsided the asexual sporozite invades the tissues—possibly the reticulo-endothelial system, the liver and the spleen—where it is inaccessible to some drugs and whence periodically the form is discharged into the blood-stream in which the cycle is re-commenced leading to symptoms characteristic of relapse. It must be stressed, however, that these tissue forms have not yet been demonstrated in man, although an exo-erythrocytic form has been demonstrated in birds. According to modern theory the existence of the tissue forms is postulated to explain the mechanism of relapse, and the persistency of the tissue form to explain the frequency of relapses. Such a postulate also explains the differences between *vivax* and *falciparum* infections as to rate of relapse and time of infection. It also explains the difference in strains especially as between "normal" *vivax* strains and the particularly obstinate S. Pacific strain of *P. vivax* which is characterised by persistency and high relapse rate and which will be referred to below. It has been pointed out that the life history of the parasite might be summarised thus:

$$\text{sporozites} \rightarrow \begin{matrix} \text{exoerythrocytic} \\ \text{forms} \end{matrix} \rightleftharpoons \text{blood forms}$$

Drugs acting on the first form would be a true causal prophylactic. Drugs acting on the second form would be prophylactics and/or curative, while drugs acting on the third form would be suppresives.

Clinical Symptoms

In the meantime, after clinical symptoms from the first attack have subsided, in addition to the spore-like forms which invade the tissues, male and female gametocytes remain in the blood stream. In the event of a further bite from an anopheline mosquite, gametocytes are sucked into the stomach of the insect where they commence the sexual phase of the life-cycle. The gametocytes fuse to form a zygote which penetrates the wall of the stomach where it forms an oocyst. This latter develops and eventually bursts to expel sporozites, some of which pass to the insect's salivary gland whence they infect the next human host and thus re-commence the life-cycle.

This brief sketch varies in detail among the various species of importance which convey human malaria. The principle species concerned are:

Plasmodium vivax—producing benign tertian malaria.

Pl. falciparum—producing malignant tertian malaria.

Pl. malariæ—producing quartan malaria.

There are, of course, other species which produce malaria only in birds, and the early German workers found that birds and avian species and plasmodium were useful in "screening" potential and synthetic anti-malarials from the earliest days of their studies of anti-malarial drugs.

In order to control malaria, which is said to be contracted by millions of people every year, it is clear that the life-cycle of the plasmodium must be broken at one or more points. Such control may be possible of achievement in two directions. Either the mosquito which is the vector must be controlled by eliminating it from its haunts; or chemotherapeutic agents must be found which on administration to man stops the development of the plasmodium. Each of these methods is fraught with difficulties not the least being the vastness of the problem. Each method has been attempted in relatively local senses during the war among military groups in defined operational areas. The first approach depends, fundamentally, on the availability of cheap and effective insecticides. The second approach depends upon the availability of cheap and effective chemotherapeutic agents.

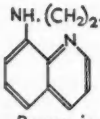
Insect Vector Control

It is probable that there is a near limit to what can be achieved in the way of controlling the insect vector and for the present, at least, it would seem that the most promising results are likely to be found in controlling the life-cycle phase in man. This can be achieved in theory in a number of possible ways. In the first place a true causal prophylactic could be sought which by being maintained at an appropriate level in the blood stream would prove immediately toxic to the sporozites injected at the time of the mosquito bite. In the second place, a suppressive could be developed which, while not destroying the organism at the time of infection, would suppress it at the time when the clinical symptoms would normally exert themselves. Finally, a drug might be developed which not only acted as a suppressive by controlling the development of the plasmodium at the point at which it gave rise to the clinical symptom, but it might in addition by continued administration, gradually eliminate the infection from blood-stream and tissues thus acting as a curative agent.

For centuries the extract of cinchona bark, and latterly totaquine and quinine were the only known agents which effectively controlled malaria. Quinine controls malaria on account of its toxicity towards the so-called schizonts in the erythrocytic phase—*i.e.*, when the parasite is developing within the red cells (the erythrocytes) in the blood stream. It is ineffective against the sporozites injected by the mosquito and

therefore is not a prophylactic, and it is ineffective against the forms which invade the tissues after an attack has subsided and it is not, therefore, curative. The disadvantages of quinine are that it is somewhat toxic in effective doses and may give rise to symptoms known as "cinchonism"; it has a tendency to cause black-water fever which may end fatally; relapses occur frequently and they may amount to 50-70 per cent of the cases in tertian fever; treatment with quinine is prolonged and may last from 3 to 4 weeks. Quinine was far from the ideal chemotherapeutic agent.

The first effective synthetic antimalarial agent was developed by Mühlens and Roehl of the Bayer Company in the 1920's. It was a substituted 8-aminoquinoline derivative called plasmoquin ("Pamaquin," B.P. 1932; 3rd Addendum, p. 14; 4th Addendum, p. 24) and is diethylaminoethyl-8-aminoquinoline. One method of manufacture of pamaquin is to nitrate *p*-methoxyacetanilide in the 2-position. The nitro compound is hydrolysed to yield the corresponding aniline derivative. By means of the Skraup synthesis this compound is converted to 6-methoxy-8-aminoquinoline which is reacted with 1-methyl-4-diethylaminobutane chloride to give the pamaquin base. Pamaquin had the advantage of being toxic to the gametocytes of subtertian and malignant malaria which, it will be remembered, are imbibed from the blood-stream by the mosquito to form a zygospore in her stomach. The action of this drug on the sexual gametes was therefore in contradistinction with that of quinine which was toxic only to the non-sexual form within the cells in the blood-stream. The two drugs were naturally used in combination to advantage especially during the war, but the treatment still required 14-21 days. Moreover, the objective of a synthetic quinine substitute had not been found.

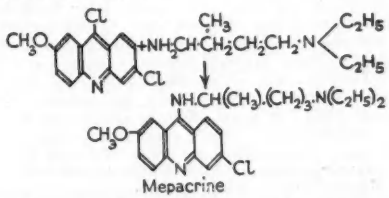


Pamaquin

Clearly, from the fact that pamaquin was effective against the gametes which infected or re-infected the biting mosquito, it was to be expected that pamaquin would be effective in reducing the number of "carriers," but from the point of view of the clinical control of the disease, this has not been regarded as of importance. Nevertheless, the treatment of benign tertian with daily doses of 30 grains quinine with 0.03 gm. pamaquin daily leads to the complete eradication of *vivax* infection. However, the required dose of pamaquin is very near the toxic limit and the treatment requires cautious application in hospital.

Continuing the search for a schizont control Roehl explored the acridine series and developed atebrin ("Mepacrine," B.P. 1932; 3rd. Add., 14, etc.), which is 2-chloro-5 (ω - diethylamino-α-methylbutylamino)-7-methoxyacridine, as an effective schizonticide.

The development of mepacrine production by the Allies was a feature of the early years of the last war. In late 1941 at least one pilot plant for the manufacture of mepacrine had been established in Britain. Later the drug was manufactured by three firms with pooled research and manufacturing knowledge and by the end of 1943 production had reached 1000 kg. per month. Eventually one firm alone, in Great Britain, is reported to have been producing 100 tons mepacrine per annum which is sufficient for 2000 million tablets. Manufacture of the nucleus is achieved in one British process (*Ind. Chem.*, March, 1946, p. 137) by converting acetanilide in stages to 2 : 4-dichlorbenzoic acid which is coupled with *p*-anisidine to give a diphenylamine derivative which is subject to ring closure to give the substituted acridine nucleus of mepacrine. The molecule is completed by condensing 2-amino-5-diethylaminopentane (built up from diethylaminoethylalcohol) to give the side chain to the 2 : 5-dichlor-7-methoxyacridine nucleus.



Mepacrine

While history may show that the free availability of mepacrine to troops was one of the deciding factors in the achievement of victory the fact remains that the manufacture is complicated and expensive and Curd and Rose consider that the drug is placed beyond the reach of poor communities. Nevertheless, it is reported (*Pharm. J.*, 1946, *156*, 128) that mepacrine hydrochloride is on sale at post offices in Bombay in packets of four at the price of half-an-anna per tablet; not more than 16 tablets are sold to any one person at one time.

Mepacrine resembles quinine in its therapeutic effects. Both are active against the asexual forms in the erythrocytic phase, but not in the exo-erythrocytic phase; neither is effective against the forms which invade the tissues after the subsidence of the clinical symptoms of the attack. Each is complementary to pamaquin. Broadly speaking mepacrine has the same usefulness of qui-

nine but they differ in their toxic manifestations. The principle advantages of mepacrine over quinine are that the former requires a shorter period of treatment, the action is more reliable and the tolerance as good. Relapse rate is less than with quinine and it can replace quinine in blackwater fever and in cases of quinine idiosyncrasy. The disadvantages of mepacrine are skin pigmentation; occasional intolerance and undesirable side reactions and, as already pointed out, the complexity and cost of synthesis.

Clinical manifestations may be controlled in a few days with either mepacrine or quinine. Relapses may occur in benign tertian with either but the continuation of mepacrine administration for two to three weeks after the main attack has been suppressed may eradicate malignant tertian infection (*Brit. Med. J.*, March 23, 1946, 458). The aim of mepacrine treatment is to build up a concentration of about 30 micrograms of mepacrine per litre of plasma and, thereafter, to hold this concentration with maintenance doses.

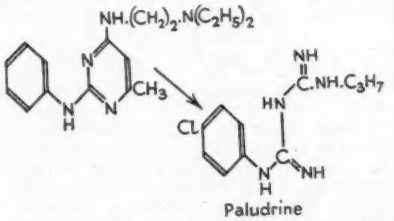
Effectiveness of Mepacrine

An editorial in the *Journal of the American Medical Association* (1945, *129*, 1091) has assessed the effectiveness of mepacrine thus: "There is no question of the general superiority of mepacrine over quinine both for suppression and for clinical treatment. Since mepacrine treatment has become widespread the clinical form of *falciparum* malaria has been almost eliminated and deaths from malaria are very rare."

Despite the achievement with the German discovery, mepacrine, the search has continued for more effective, less toxic and constitutionally more simple anti-malarial drugs. The need for a more effective anti-malarial than mepacrine was felt most urgently in the South Pacific theatre of war where the prevalent most virulent strain of *P. vivax* was found to resist cure by either mepacrine or quinine which was in contrast with the success achieved on *P. vivax* in the U.S.A. These efforts have met with considerable success both in Britain and America. In these countries the developments have been along different lines. In America a most comprehensive programme was undertaken to "screen" derivatives of 8-aminoquinoline (the neucleus of pamaquin); whereas, in Great Britain, the approach was, perhaps, more fundamental and was directed towards the establishment of the groupings in the mepacrine molecule which were responsible for the chemotherapeutic effect and the consequent synthesis of molecularly more simple antimalarial drugs. This work has led to the discovery of "paludrine" in Great Britain and "Chloroquin" as well as other similar drugs in the U.S.A.

The discovery of paludrine was announced in November, 1945 (Curd, Davey & Rose, *Ann. Trop. Med. and Parasitol.*, 1945, *39*, 53; Macgraith *et. al. ibid*, 232) since when the chemical work, which led to the ultimate discovery of paludrine, has been published in a series of memoirs by Curd and Rose in the *Journal of the Chemical Society* during 1946. Those workers have pointed out elsewhere (*Chem. and Ind.*, 1946, 75) that most attempts to find more effective antimalarials than quinine, pamaquin and mepacrine have been centred on the quinoline and acridine heterocycles as they represent the nucleus of pamaquin and mepacrine respectively. Since this approach had not appeared profitable, work was directed to exploring the possibilities of pyrimidine derivatives since it was known that sulphadiazine possessed slight antimalarial properties; moreover, the pyrimidine nucleus is known to be of biochemical importance in nucleoproteine and enzyme systems. It was hoped that by analogy with the sulphonamides a compound could be evolved which would "block" some vital system in the malaria parasite. An additional point of importance was that there existed some grounds for believing that the antimalarial properties of mepacrine were associated with molecular tautomerism and it was known that 4-dialkylamino derivatives of pyrimidine exhibited an analogous tautomeric system.

An examination of positional isomers of certain derivatives in the 4-dialkylaminopyrimidine series led to the conclusion that an essential requirement for antimalarial activity was a molecule with two linked, but independent amidine systems and that the intact pyrimidine ring, in which the amidine grouping is implicit, might not be necessary. Omission of carbon atoms 5 and 6 in the pyrimidine ring leave a biguanide linkage and an exploration of biguanide derivatives led to the discovery of paludrine which is N_1-β-chlorophenyl-N_5 iso-propylbiguanide.



Paludrine

There are a number of routes by which paludrine may be synthesised but the original method of synthesis (*J. Chem. Soc.*, 1946, 729) is achieved by coupling diazotised *p*-chloraniline with dicyandiamide to give stable wet paste after filtration which is decomposed with concentrated hydro-

chloric acid in β-ethoxyethanol at 20-40° C. to give the crude *p*-chlorophenyldicyandiamide which is finally condensed with isopropylamine to give paludrine.

$$Cl.C_6H_4.N = NCl + NH_2\ C\ (NH).NH.CN$$

$$\downarrow$$

$$Cl.C_6H_4.N = N.NH.\ C(NH) = NHCN$$

$$\downarrow$$

$$Cl.C_6H_4.NH.C(NH) = NH.CN + C_3\ H_7\ NH_2$$

$$\downarrow$$

$$Cl.C_6H_4.NH.C(NH).NH.C = (NH).NH.\ C_3H_7$$

Paludrine was found to be more effective than either mepacrine or quinine for the treatment of clinical malaria since it is very much less toxic than either. It is an efficient suppressive and a more certain cure for malignant tertian (*falciparum*) than mepacrine; but most important of all it has been found to be a true causal prophylactic in falciparum malaria although its prophylactic effect is only partial in benign tertian (*vivax*). This is the first occasion in which a drug has been found which is actually capable of preventing infection. However, the assessment of paludrine, which has been made freely available in the last month of 1946, awaits further experience.

Fairley's Work

The major examination of paludrine in the field was carried out by Brigadier H. Fairley in Australia (*Lancet*, 1946, No. 6391, 278) who determined its efficiency on mosquito conveyed strains of *P. vivax*, *P. falciparum*, and *P. malaria* as: (1) a clinical suppressive; (2) a true causal prophylactic; (3) a therapeutic agent; (4) a gametocidal agent. He confirmed early findings that in malignant tertian (*falciparum*) paludrine is an effective clinical suppressive and a true causal prophylactic; whereas, in benign tertian (*vivax*) it is an effective clinical suppressive, but not so effective a causal prophylactic as in *falciparum*. Fairley found that, with a suitable regimen paludrine achieved clinical cure of malaria. It was also found to be ineffective against gametocytes.

Fairley innoculated blood from benign tertian patients into donors taking paludrine. The disease failed to develop in these persons which was by contrast with the opposite which was known to occur with mepacrine and quinine in attempted prophylaxis. It is concluded, therefore, that paludrine acts on a different form of the parasite from mepacrine or quinine. It is known that, in avian malaria, paludrine acts on the exo-erythrocytic forms and it is to be presumed that paludrine acts similarly on the exo-erythrocytic forms in the human host. Mepacrine and quinine are, of course, effective against the erythrocytic forms (*i.e.*, the forms infecting the red blood corpuscles) only. Some evidence was obtained that, where the mosquito had taken a blood meal from a host receiving paludrine, the early development stages of that part of the life-cycle which takes place in the mosquito was affected.

Fairley also confirmed that a small weekly dose of paludrine for an indefinite period after therapeutic control of the primary malarial attack had been achieved by the same drug prevented relapse in benign tertian (but *see* Johnstone below) until eradication of the parasite was achieved. He found paludrine to be non-toxic within a wide therapeutically effective range of dosage.

Macgraith *et. al.* (*Brit. Med. J.*, 1945, 903) found no serious side-effects when benign tertian was treated with 10-750 mg. and malignant tertian was treated with 50-600 mg. for each of 14 days although 500 mg. or more twice daily sometimes caused nausea and vomiting; 50-400 mg. daily produce clinical cure of relapsing or delayed primary benign tertian, an effect which can also be achieved with mepacrine in 400 mg. doses.

Johnstone (*Lancet*, 1946, *2*, 825) has reported on relapse rate in three groups, each of 108 cases, suffering from benign tertian (*vivax*) malaria each of which was given one of three courses. The daily dose was a divided one and the relapse rate was determined after six months. The results were as follows:

1. Paludrine, 0.05 g. daily for 10 days: Relapse rate 30.5 per cent.
2. Paludrine, 0.50 g. daily for 10 days; relapse rate 23.3 per cent.
3. Quinine, gr. 30 with pamaquin 0.03 g. daily for 10 days; relapse rate 9.2 per cent.

Pamaquin-Quinine Treatment

The use of the pamaquin/quinine treatment for eradication has already been referred to and this established treatment acted as a control. In this case the figure of 9.2 per cent compares satisfactorily with previously obtained figures of 10.3 per cent and of 11.3 per cent with this combination in proved cases. It will be seen that the relapse rate with paludrine whether with large or small dose is about double that with the control drugs.

The estimation of paludrine in body fluids was clearly an important feature in determining its biochemical status. Spinks and Totly developed a method depending upon a pressure hydrolysis of paludrine and a coupling of the resulting *p*-chloraniline with azo-dye. Wooton and Gilchrist (*Lancet*, June 15, 1946, 886) have modified a method developed for earlier anti-malarials in which paludrine is extracted from body fluids with concentrated caustic soda and shaken out with benzene/alcohol. The ex-

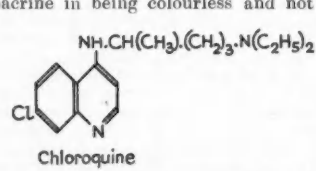
tract is then shaken with bromthymol blue at room temperature at *p*H 7.0 when coupling takes place to give a benzene soluble complex while uncoupled. The benzene solution may be shaken with aqueous alkali which splits the complex and dissolves out the bromthymol blue. However, to reduce the manipulations, the decrease in content of bromthymol blue after coupling may be estimated and the method gives good agreement with that of Spinks and Totley.

American Developments

In the meantime, while paludrine has been developed in Britain, with characteristic verve the U.S.A. has attacked the problem of synthetic antimalarials on a grandiose scale. This followed justifiably from the colossal nature of the problem which confronted them in military operations in the S.W. Pacific. Sapero (*J. Amer. Med. Ass.*, 1946, *132*, 623) is of the opinion that there were nearly a million cases of malaria among troops in the last war many of whom, as already pointed out were infected with the virulent S. Pacific strain of *P. vivax* which was not susceptible to cure by mepacrine or quinine. It is reported (*Ind. and Eng. Chem.*, 1946, *38*, 8) that 14,000 compounds were synthesised and tested during the war, and of these, ten were found to be effective against malaria parasites infecting man. The work was carried out under U.S.A. Government auspices at a cost of £2,000,000. Publication has now been undertaken in a series of memoirs in the *Journal of the American Chemical Society*, during 1946, of the chemical aspects of this great work of exploration. The methods are described by which not only the antimalarials themselves are synthesised, but also the different variations on the quinoline nucleus and the alkylamino acid chain. The clinical assessment of many of these drugs is still in progress and in many cases the results have not yet been made available. It is understood that this work will be summarised in a survey which is at present in the press.

In the meantime two of the drugs which have been evolved from this work—" chloroquine " and " pentaquine " have already received some considerable assessment, particularly the former.

It appears that the Americans developed " chloroquin " from earlier German work following the capture of a sample under the name of " sontoquin " (or " 6911 ") from the Germans at Tunis in 1943. I.G. Farbenindustrie had synthesised sontoquin before the war, but had considered it not to have had any advantages over mepacrine (atebrin) and so had not pursued its development very vigorously. The drug had been described in the patent literature (*e.g.*, U.S.P. 2,233,970 of March 4, 1941). The Americans thoroughly explored this drug and its synthesis was first described in the scientific literature by Tarrey and Hammer (*Journ. Amer. Chem. Soc.*, 1946, *68* 113) and later Drake *et. al.* (*Journ. Amer. Chem. Soc.*, 1946, *68*, 1214)) described the synthesis of the base and its solvent-free diphosphate from 4 : 7-dichloroquinoline and 4-diethylamino-1-amino-pentane to give 7-chloro-4(4-diethylamino-1-methylbutylamino)-quinoline, —" chloroquine " or " SN-7618." In the case of this drug and the many variants prepared and examined, so far as possible the synthesis followed the usual course of preparing the appropriate chloroquinoline from the corresponding hydroxyquinoline which, where possible, was prepared by a modified Skraup reaction. However, according to the required substituents in this series these procedures had to be considerably modified in many cases. These modifications are given *in extenso* in the various issues of the *Journal of the American Chemical Society* during 1946. An approved statement on the clinical assessment of chloroquine has been issued by the Board for the Co-ordination of Malarial Studies (*Journ. Amer. Med. Ass.*, 1946, *130*, 1069) who state that it resembles mepacrine in its almost complete absorption from the gastro-intestinal tract and in its excretion and its distribution in the tissues; but it has the advantage over mepacrine in being colourless and not pig-



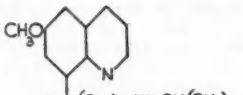
Chloroquine

menting the skin. It is, like mepacrine, largely metabolised in the body and about 10-20 per cent is excreted in the urine, the actual amount depending upon the hydrogen ion concentration. Like mepacrine, chloroquine will suppress acute attacks of *falciparum* malaria and will, ultimately, effect a complete cure. In *vivax* infections the drug is toxic to the erythrocytic form and does not control relapses.

Discovery of " Pentaquine "

In the search for a drug which would be less toxic but equally effective as pamaquin, especially in the pamaquin/quinine combination already described, another useful antimalarial has been found in " pentaquine " (" SN-13,276 " or 6-methoxy-8-(5-isopropylaminoamylamino)-quinoline) the preparation of which is described by Drake *et. al Journ. Amer. Chem. Soc.*, 1946, *68*, 1529) by the smooth condensation of the side chain, 1-chloro-5-isopropylaminopentane hydrochloride, with the nucleus, 8-amino-6-methoxyquinoline. The side chain itself is prepared from dihydropyran by

hydrogenation with Adams catalyst and isopropylamine at *p*H 8.0 followed by subsequent chlorination with thionyl-chloride.



Pentaquine

An approved statement by the Board for the Co-ordination of Malarial Studies (*Journ. Amer. Med. Soc.*, 1946, *132*, 321) finds that in metabolism, excretion, distribution in the tissues, etc., pentaquine resembles mepacrine. In a limited series of toxicity studies pentaquine was found to be half to three-quarters as toxic as pamaquin but was proportionately more toxic at doses above the therapeutic dose. Clinical experience has, so far, been restricted to a limited number of cases infected with a virulent S.W. Pacific strain of *P. vivax*. Pentaquine has been found to be a partial prophylactic at toxic dosage only and it is considered unwarranted to use the drug for prophylaxis or prolonged suppression. Cure of *P. vivax* infection has been achieved when administered in daily dose of 60 mg. base (80 mg. diphosphate) with 2 grammes quinine in divided doses four hourly for 14 days, but hospitalisation is necessary. Much work remains to be done on the assessment of this drug and trials continue.

The effectiveness of the various drugs so far mentioned is briefly summarised in the following table. It is to be remembered, however, that such a summary necessarily acquires the faults of over-simplification and conclusions are to be drawn from this table with caution.

On the basis of the hypothesis that the postulation of an exo-erythrocytic or tissue form in man is valid it will be appreciated as the table shows that in the case of *P. vivax* infections, at least, mepacrine, quinine and chloroquine which react on the erythrocytic forms can control the clinical symptoms, but not effect relapse. Whereas, paludrine, pamaquine and pentaquine which may be supposed to be toxic towards and to eradicate the hypothetical tissue forms can prevent the periodic infection of the erythrocytes which is characteristic of relapse and thus bring about cure.

Mainly effective against :		*P. vivax* (benign tertian) "Normal" strains	*P. vivax* (benign tertian) Virulent S.W. Pacific strain	*P. falciparum* (malignant tertian)
erythrocytic forms	Quinine	S.	S. (failed C.)	S.C.
	Mepacrine	S.	S. (failed C.)	S.C.
	Chloroquine	S.	S.	S.C.
	Pamaquine	C.*		ϕ
exo-erythrocytic or tissue forms	Pentaquine		Partial C.* Partial P.*	
	Paludrine	Partial P. S.C (?)		S.C. P.
	Quinine plus Pamaquine	C.		
	Quinine plus Pentaquine		C.	

S = clinical suppressive; C = curative; P = true causal prophylactic.
* = in toxic dosage.
ϕ = destroys gametocytes and, therefore, reduces number of carriers.

(To be continued)

National Laboratories for India

India's scheme to set up four more National Laboratories at an estimated capital cost of Rs. 13,200,000 has been launched. The plans for these were approved recently by the Governing body of the Council of Scientific and Industrial Research. The first of the planned laboratories for the industrial development of the country was the Central Glass and Ceramic Research Institute costing about Rs. 1,200,000. The foundation stone of this was laid by Sir Ardeshir Dalal, former Member for Planning and Development, last December at Calcutta.

New Palestine Superphosphate Factory

Realising the importance of the superphosphates factory of the General Chemical Products Corporation of Palestine, Ltd., the Jewish National Fund has leased to the Corporation a plot of 18 acres in the industrial zone of Haifa Bay for the manufacture of fertilisers. On this land a large and modern factory, supplied with English equipment, is being built.

Utilising pure sulphuric acid, the Corporation's new enterprise will open on June 1, 1947, on which date the present factory at Kiriat Arieh, near Tel Aviv, will close down.

Chemical Exports in 1946

A SUBSTANTIAL increase in the exports of British chemicals is reflected in the trade accounts for 1946 just issued (*Trade and Navigation Accounts of the U.K.*, 1946; H.M. Stationery Office, 4s. 6d. net). Although there are several categories still well below the pre-war levels, the overall picture bears witness to solid achievement in recovering and increasing business suspended for some seven years. Among items typical of the general trend, copper sulphate 52,161 tons (1945, 44,317 tons), carbonates, soda ash, etc., 4,208,852 cwts. (1945, 3,888,325 cwts.), caustic, 3,102,425 cwts. (1945, 2,987,133 cwts.) all registered good increases. In some items the rise in exports was exceptional, an example of this being nitrate, of which exports in 1946 were 130,226 tons, as against 37,376 tons in the previous year, and only 16,326 tons in the year prior to the war. The same tendency was observable in the shipments of cresylic acid in 1946, 2,970,407 galls., compared with 2,263,265 galls. in 1945, nearly double the 1938 export total.

An almost equally satisfactory state of affairs, from the point of view of finance, is shown on the other side of the ledger, import totals being generally somewhat less than in 1945. Some reduction is shown in arrivals from overseas of most acids (acetic 71,362 cwts. against 79,105 cwts. in 1945) but an exception was tartaric acid, which, at 15,875 cwts., nearly doubled the previous year's total. Fertilisers were another group in which the inward trade showed a very marked increase, from 98,929 tons in 1945 to 237,045 tons last year, and chloride (muriate) also rose from 3,311,813 cwts. in 1945 to 4,509,090 in 1946.

Exports of metals also showed marked increase as evidenced by the export trade in iron and steel manufactures of 275,117 tons (1945, 78,528 tons), and the comparable increases in the non-ferrous metals, excepting lead.

PRE-WAR AND POST-WAR TOTALS

EXPORTS OF CHEMICALS

	December, 1946		Year 1946		Year 1938	
	Cwts.	£	Cwts.	£	Cwts.	£
Citric acid	1,179	8,924	21,1772	166,164	31,167	139,024
Other acids	—	83,073	—	985,592	—	281,617
	Tons		Tons		Tons	
Aluminium compounds	2,455	40,375	44,386	661,377	28,322	263,348
Ammonium sulphate	12,010	170,886	277,925	3,804,719	313,393	2,053,150
Ammonium nitrate	8,827	213,530	130,266	3,030,553	16,326	169,667
Other sorts	1,026	34,773	20,795	602,117	6,362	123,399
	Cwts.		Cwts.		Cwts.	
Bleaching materials	39,460	43,203	885,244	981,045	619,857	297,210
	Galls.		Galls.		Galls.	
Benzol	29,255	5,749	1,207,936	178,685	48,840	4,642
Cresylic acid	150,368	46,118	2,970,407	787,588	1,961,652	279,869
	Cwts.		Cwts.		Cwts.	
Naphthalene (excluding naphthalene oil)	4,253	9,804	55,078	132,797	64,541	44,717
	Galls.		Galls.		Galls.	
Tar oil, creosote oil, anthracene oil and other heavy coal tar oils, etc.	264,348	22,138	5,990,191	376,236	36,339,295	885,980
	Tons		Tons		Tons	
Copper sulphate	968	33,596	52,161	1,565,779	30,907	510,254
	Cwts.		Cwts.		Cwts.	
Disinfectants, weed-killers (except tobacco offal and nicotine), and cattle and sheep dressings	85,326	305,636	847,457	3,647,061	377,504	786,112
	Tons		Tons		Tons	
Manufactured fertilisers	3,566	37,876	17,404	192,678	146,360	669,433
	Cwts.		Cwts.		Cwts.	
Glycerine	7,137	29,221	120,148	474,638	105,576	393,829
Lead compounds	8,415	31,600	110,370	293,795	169,919	236,520
	Tons		Tons		Tons	
Magnesium compounds	661	33,639	9,669	413,879	4,960	125,766
	Cwts.		Cwts.		Cwts.	
Potassium compounds	7,903	49,451	113,608	637,486	58,543	119,068
	Tons		Tons		Tons	
Salt	9,533	53,492	168,877	942,517	232,419	643,947
	Cwts.		Cwts.		Cwts.	
Sodium carbonate, including soda crystals, soda ash and bicarbonate	247,178	93,014	4,208,852	1,529,182	3,756,186	871,856
Caustic	169,751	129,273	3,102,425	2,259,347	1,948,324	1,041,086
Sodium sulphate	34,337	10,935	1,050,949	270,736	596,273	78,027
Other salts	68,426	173,750	1,164,746	2,423,652	556,291	846,612
	Tons		Tons		Tons	
Zinc oxide	1,234	64,452	22,895	945,251	14,444	268,261
Total chemical manufactures and products, excluding drugs and dyestuffs	—	2,625,791	—	39,360,460	—	13,984,176

EXPORTS OF CHEMICALS (Continued)

	December, 1946		Year 1946		Year 1938	
	Tons	£	Tons	£	Tons	£
China clay	20,690	91,459	210,896	800,050	366,538	698,145
	Cwts.		Cwts.		Cwts.	
Dyes and dyestuffs	33,085	557,931	428,008	6,331,944	295,436	1,406,516
Paraffin wax	3,016	8,451	11,546	35,817	88,016	75,911

IMPORTS OF CHEMICALS

	December, 1946		Year 1946		Year 1938	
	Cwts.	£	Cwts.	£	Cwts.	£
Acetone	7,188	18,975	8,194	21,882	37,064	48,808
Acetic acid	5,239	12,682	71,362	152,838	112,175	139,244
Boric acid	2,500	5,694	11,480	28,024	32,834	36,538
Citric acid	1,000	12,269	5,000	61,326	21,057	85,516
Tartaric acid	3,680	40,763	15,875	189,483	23,195	106,914
Other acids	229	1,196	1,532	33,086	152,052	90,492
	Tons		Tons		Tons	
Ammonium phosphate	1,786	36,000	18,273	354,018	649	9,722
Arsenic (except metallic)	352	10,458	4,278	107,795	3,985	40,788
	Cwts.		Cwts.		Cwts.	
Borax	25,500	35,144	87,681	123,538	160,931	99,205
Bromine and bromides	485	3,528	11,692	3,535	18,938	63,254
Calcium carbide	—	—	4,440	4,941	1,316,504	629,993
Coal-tar products, excluding benzol and cresylic acid	1,511	7,847	55,653	198,413	6,273	9,171
Fertilisers	15,097	195,930	237,045	2,752,978	37,967	166,580
Glycerine	230	1,418	387	2,606	46,734	129,452
Iodine	503,159	199,415	1,154,068	457,764	726,100	146,342
Phosphorus	4,032	21,462	7,232	38,055	31	145
Caustic and lyes	140	1,294	36,693	85,807	129,212	145,869
	Cwts.		Cwts.		Cwts.	
Potassium chloride	393,894	260,754	4,509,090	3,068,311	1,783,304	586,848
Kainite and other potassium fertiliser salts	—	—	—	—	1,244,491	200,035
Saltpetre	—	—	6,146	12,242	50,530	41,370
Sulphate	39,910	41,650	62,664	60,986	876,463	404,877
Other potassium compounds	1,800	6,994	13,962	59,766	125,006	169,119
Sodium nitrate	—	—	904,280	596,932	1,112,504	273,640
Sodium phosphate	—	—	4	89	40,157	19,102
Other compounds	1,488	4,618	15,497	36,137	236,200	283,878
Total sodium compounds	1,488	4,618	15,497	633,158	1,388,871	576,620
Industrial ethyl alcohol, mixed or otherwise	—	—	Pf. galls. 5,919,434	537,890	—	—
	Tons		Tons		Tons	
Sulphur	31,460	264,422	248,511	1,967,405	131,488	571,607
	Cwts.		Cwts.		Cwts.	
Dyes and dyestuffs	342	26,717	3,776	308,525	428,281	1,361,056
Extracts for dyeing	10	108	20,012	89,975	40,147	80,903
Extracts for tanning	57,541	88,514	1,400,430	2,141,507	983,296	816,630
Pigments and extenders :—	Cwts.		Cwts.		Cwts.	
White lead	—	—	—	—	69,176	96,326
Ochres, earth colours and natural iron oxide	10,131	6,924	329,098	186,912	470,842	147,848
Carbon blacks	96,109	250,103	652,478	1,685,403	386,208	512,754
Other blacks	981	4,493	16,796	63,815	43,961	64,762
Lithopone and pigments containing zinc sulphide	1,400	2,988	1,400	2,988	298,498	184,567
Other dry pigments and extenders	16,971	9,219	304,615	160,913	526,415	122,660
	lbs.		lbs.		lbs.	
Essential oils, excluding turpentine	425,964	340,421	4,714,645	3,565,259	4,563,515	1,082,916
Synthetic oils	715	3,206	10,392	73,986	120,208	139,133
Turpentine	8,542	43,647	48,733	176,325	411,484	421,523
Paraffin wax	93,631	224,551	667,313	1,371,255	809,749	635,036

EXPORTS OF METALS

	December, 1946		Year 1946		Year 1938	
	Tons		Tons		Tons	
Iron and steel tubes and fittings for wrought tubes	25,838	1,131,868	275,117	11,462,151	219,973	5,277,652
	Cwts.		Cwts.		Cwts.	
Aluminium and alloys, ingots, wire-bar, granules, etc.	13,175	46,529	104,128	364,782	30,151	140,970
Brass and copper alloys, ingots, etc.	29,978	161,389	480,139	1,894,830	64,366	203,568
Brass manufactures	369,569	559,652	3,152,322	7,203,978	367,115	2,050,183
	Tons		Tons		Tons	
Copper, unwrought	1,219	102,836	19,221	1,291,226	10,468	475,009
	Cwts.		Cwts.		Cwts.	
Copper manufactures	68,829	444,447	1,083,076	6,254,906	438,960	1,509,221
	Tons		Tons		Tons	
Lead, unwrought	11	709	782	34,470	6,577	117,276
Lead, sheet and manufactures	70	8,822	2,977	226,944	8,213	256,085
	Cwts.		Cwts.		Cwts.	
Nickel, unwrought	13,369	132,945	87,088	881,459	245,775	2,210,645
Nickel alloys and manufactures	7,048	123,881	63,474	1,191,381	50,828	561,211
Tin solder	1,028	11,653	36,864	343,553	39,152	186,508
Tin, unwrought	1,013	384,521	20,605	7,639,123	12,281	2,371,097
Zinc or spelter and manufactures	327	36,478	7,608	591,190	5,710	145,898

EFFECTS OF THE COAL CUTS

Lower Production and Short Time

HOPES that the new system of reduced allocations of coal to industry might have beneficial results in producing a dependable supply not necessarily smaller than the unpredictible deliveries customary in the past few months have not been realised. Reports from the centres of chemical and allied industries and from the iron and steel organisations indicate that, since the new allocations were announced locally this week, supplies of fuel and prospects of future supplies have not improved. The prospects of receiving in full in the immediate future the promised 50 per cent of earlier allocations are not sufficiently good to enable any long-term plan of production on this basis. Generally, "hand to mouth" economy is still the rule.

Official Statement

Typifying the statements which have been issued in the past few days to chemical manufacturers and others by Regional Coal Boards was that circulated this week by the Fuel Allocation Committee of the Midland Board, which concluded with the warning: "It is only open to manufacturers to adjust their production to the supplies available, and to exercise in every section of fuel use the greatest possible measure of economy." To meet the situation that available coal supplies were insufficient, it was stated, firms would be entitled to and would receive, "subject to any special and unavoidable transport difficulties," 50 per cent of their allocations. For iron and steel firms and industrial coke ovens the expected delivery rate would be about 75 per cent of their previous allocations. The committee had in addition a small coal pool with which to supplement at their discretion the allocations of firms "on work of particular importance."

One of the more drastic effects of the shortage is reported from Rutherglen, Scotland, where at Messrs. J. & J. White, Ltd., 150 chemical workers were idle last week-end and it was stated that there was no alternative but to close the plant because of shortage of fuel. This factory was among those lately threatened with a shortage of raw materials from I.C.I., Ltd., themselves suffering a fuel shortage. That shortage has been alleviated, but the Rutherglen plant now finds itself without the necessary fuel to utilise the raw materials.

The serious situation developing in the chemical engineering industry was outlined by Watson Laidlaw & Co., Ltd., chemical engineers, Glasgow. The inevitable result of the 50 per cent cut—which applies to engineering production as well as to consumer and other goods—this firm points out, must be to swing back delivery dates seriously and limit the impetus of the re-equipment of industry at home and abroad. The position of engineering and machinery building firms is even more serious than that of other industries since they are being hit twice—by the limitation of raw materials as well as of fuel for their own processes. Raw materials supplies are already desperately limited and will remain so with, inevitably, a further deterioration as the effect of the 25 per cent fuel cut to steelworks is reflected in the output of steel.

On top of this, the chemical engineering firms are now subject to a 50 per cent cut in their own fuel allocations, with the reservation that they can appeal for increased supplies to the Board of Trade if their outputs are affected. That such appeals will be made is obvious, but what effect these will have remains to be demonstrated. There is no evidence that any special consideration is being shown for export business; and, although chemical engineering firms are heavily committed and working up to 60 per cent on export, they have been given no relief from the latest cuts. Delays in delivery and extension of existing delivery dates is regarded as inevitable, and some unemployment seems bound to occur pending an improvement in coal supplies.

One of the most serious aspects of the present situation, it is pointed out in Scotland, is the fact that firms which have co-operated fully in the past in fuel economy are now being subjected to the same cuts as are firms which have not reduced their consumption. The allocation for some firms is accordingly based on figures derived from uneconomic methods of working, and they can now reap the advantages conferred by adopting fuel efficiency methods. More alert and progressive firms—which have already adopted all the fuel efficiency methods open to them, can no longer screw any further efficiency from their fuel, and are in effect penalised for their earlier progressiveness.

Less Iron and Steel

Outlining the position of the iron and steel industry to THE CHEMICAL AGE this week, an official of the British Iron and Steel Federation said that the new basis of coal distribution would involve an estimated cut in production of some 250,000 tons of steel a month, a loss of 15-20 per cent. Production of pig-iron was likely to fall about 100,000 tons a month, or 15 per cent. The Federation had had no information about

the duration of the present shortage conditions beyond the general announcement by Sir Stafford Cripps last week that the emergency was likely to last six weeks. Iron and steel manufacturers generally, he said, were being obliged to reduce production hours, in some cases by adopting a four-day week. To maintain the high level of production (12,693,000 tons of steel in 1946 against a target figure of 12,750,000 tons) was for the moment out of the question, but there was a possibility that the present leeway might be made up later in the year if a substantial improvement in coal production figures was achieved. Meanwhile, the steady increase in the oil firing of furnaces was enabling some manufacturers to avoid the full impact of the coal shortage.

Chemical Plant Production

A director of the British Chemical Plant Manufacturers' Association said in London this week that their industry was likely to suffer a two-fold shortage, of raw materials such as stainless steel plates and sheets and of fuel necessary for kilning chemical stoneware and in the production of enamel vessels. Even those industries which were not immediately hampered by the smaller coal allocations, employing gas-fired installations, were equally sufferers from the overall shortage, because gas supplies in the Northern industrial areas were subject to much more drastic cuts than were common elsewhere, amounting at times to about 50 per cent. The total effect upon production of chemical plant could not yet be accurately assessed, but it was evident that the leeway in fulfilling orders would increase.

Aniline Dyes

Canadian Imports

Imports of aniline dyes into Canada during the first nine months of 1946 exceeded the amount imported during the corresponding period of 1945. For the January-September 1946 they amounted to 3,926,781 lbs., valued at $3,582,504 as against 3,162,996 lbs. valued at $2,962,597 imported during 1945 period.

During the January-September period of 1946, the United States sent Canada 3,433,779 lbs. valued at $2,856,120, while Britain shipped 329,901 lbs. valued at $349,070; in the same period of 1945, shipments from the United States amounted to 2,824,398 lbs., valued at $2,507,273 and shipments from Britain amounted to 270,934 lbs. valued at $268,634.

A large gain was recorded in imports from Switzerland during 1946 period. Imports amounted to 160,726 lbs. valued at $375,492 as against 67,664 lbs. valued at $186,690 imported during the corresponding period of 1945.

Noxious Gases

Chemical Manufacturers Fined

A FINE of £5000 has been imposed in Tel Aviv on Tassiya Chemith, Ltd., superphosphates manufacturers, for contempt of court. In 1944, an injunction was issued ordering the company to cease dissemination of noxious gases; and in 1945 the company was fined £300 for contempt of court by failure to stop spreading the gases. Licensed to work for the war effort, and protected by emergency regulations, the company carried on manufacturing superphosphates. In September, 1946, the Emergency regulations were repealed and the Beilinson Hospital sought a further injunction on the grounds that the gases were causing severe discomfort to patients.

Before the court, representatives of Tassiya Chemith, Ltd., admitted the gases were being spread but claimed the factory had been taken over by General Chemical Products Corporation.

Judge R. Windham considered the real purpose of the transfer was to enable the factory to escape the injunction.

Early in December, General Chemical Products Corporation announced that the problem would be solved by the transfer of the factory from Tel Aviv to the Haifa Bay area, where the new plant would use pure sulphuric acid and no odours would escape. The transfer is due to take place on June 1, 1947.

Modern Ice Plant

Jerusalem.—Palestine's largest ice plant, built at a cost of £64,000, has just been completed at Haifa by the General Ice Factory and Cold Storage Co. Equipped with six modern ammonia high speed compressors, the factory is at present working at half capacity producing 1100 55-lb. blocks of ice every 12 hours, or 55 tons per day. The construction of the plant embodies the latest developments in refrigeration, technique and mechanisation, and only one skilled operative is needed to handle the production of 27½ tons per shift. This combination of a minimum use of labour with a maximum of mechanisation makes the factory the most up-to-date in the Middle East and second only to a similar plant in the United States where a recently constructed "one-man" factory turns out 45 tons of ice per shift. Adjacent to the ice generating plant is a cold storage room with space for 700 tons of ice. The low temperature is preserved by the use of hollow bricks and cork insulating material supplied by the Hasha'amon Insulation Works, Tel Aviv.

The new plant will do much to ease Haifa's ice position this summer when the demands of shipping will be added to the needs of the civilian population.

Parliamentary Topics

CONTEMPORARY industrial progress and problems—notably those associated with the country-wide coal shortage—have occupied a substantial proportion of question time since the House of Commons reassembled. Here are some of the recent replies to questions affecting the chemical, metal and allied industries:—

Soda Ash Shortage

Mr. Henderson Stewart asked the President of the Board of Trade what action he was taking to remedy the situation caused by the cut in the supplies of soda ash and alkalis to the paper trade, which were likely to result in large-scale unemployment. Sir Stafford Cripps admitted there were "temporary" cuts in production of soda ash and caustic as a result of the fuel shortage, but said it was possible to maintain deliveries of caustic from manufacturers' stocks. These cuts, he claimed, had now been largely restored and industry generally, including paper mills, should be receiving sufficient supplies for their current production.

Steel Production

The restriction of steel production imposed by coal shortage was raised by Sir Patrick Hannon, who asked if the President of the Board of Trade had considered the serious situation in the Sheffield steel industry resulting from the reduction of coal allocations to 75 per cent of the November figures. Sir Stafford Cripps: "I am aware of the effect on steel production generally of the recent cut in coal allocations, but in the present coal shortage we must spread out the loss of industrial output in order to preserve a right balance in industry. I am in consultation with the Minister of Fuel about the availability of coal for the coming months with a view to seeing what future arrangements can be made for supplies to industry, including steel." Asked how, in the circumstances, the Government hoped to maintain its export policy, Sir Stafford said it was useless to provide for using coal which was not there.

No DDT Cartel

The allegation that the existence of "a cartel among manufacturers of DDT" was responsible for the fact that the full strength insecticide cost 3s. 3d. per lb. in ten-ton lots in this country, compared with 2s. 10d. in the U.S.A., was made by Mr. John Lewis, requesting a statement from the Board of Trade. Sir Stafford Cripps: I am aware that the producers of DDT in this country sell at a common price, but not as the result of the policy of my department. DDT is in free supply and is not subject to statutory control.

In a supplementary question, Mr. Lewis asked if Sir Stafford Cripps was aware "that the export of full strength DDT is prohibited from this country by a manufacturers' cartel, except to restricted markets in the Empire where it has to meet the lower-priced American competition; and if he will have an immediate inquiry made into the position with a view to assisting the British export market." The President of the Board of Trade said he was not aware of any export prohibitions. The material was subject to patent rights and was prepared under conditions negotiated with the patentees.

Plate Glass Exports

Exports of polished plate glass in November, 1946, were 29,053 cwts. (1,009,423 sq. ft.), compared with 25,088 cwts. in October and 22,410 cwts. in December, Mr. J. W. Belcher revealed in a written reply. Imports also reached a peak in the same month, totalling 9588 cwts.

Principal exports to the U.K. from the British occupied zone in Germany are timber, lead, steel scrap and potash—Mr. J. H. Hynd.

No decision has yet been taken whether the London Metal Exchange shall be reopened.

World Welding Competition

Prizes numbering 452 and valued at $200,000 are offered in the "Design for Progress" international competition sponsored by the James F. Lincoln Arc Welding Foundation, of Cleveland, Ohio, U.S.A. It is designed "to encourage and stimulate scientific interest in, and scientific study, research and education in . . . the arc welding industry." The competition, open to all interested in arc welding, invites papers or reports on the design or redesign of machines or structures, the operating of a job weldery or maintenance service, or on research or education. In each of the 43 divisions, awards of $700, $500, $250 and $150 will be made; four additional awards of $2500, $1500, $1000 and $800 will go to the best papers in 15 categories; the three papers adjudged the best of all submitted will receive the main awards of $10,000, $7000 and $5000. For the best paper in the entire competition $13,000 will be awarded and papers not participating in any of the foregoing will be eligible for one of the 217 "honourable mention" awards of $100 each. Included in the subjects under the 15 classifications are (E) Functional Machinery (machinery or parts for metal cutting; metal forming; electrical purposes; prime moving; conveying; pumping and compressing); (F) Industrial Machinery (machinery or parts for business; processing or plastics; construction; petroleum; steel making jigs and fixtures; and (L) Welderies (commercial plant).

Licensing Procedure

Unwrought Copper and Zinc

THE Ministry of Supply has revised the licensing procedure for the acquisition of unwrought copper and zinc and copper wire rods. Applications for licences to acquire unwrought copper and zinc will in future only be granted if accompanied by the following signed declarations:

1. "We certify that the quantity requested on the accompanying application is needed to cover orders for our products, and that in the case of applications for virgin metal full allowance has been made for our expected intake of scrap."

2. "We certify that, in respect of unwrought metal, our existing stocks plus our outstanding purchases, plus the tonnage now being applied for, will not exceed 7 months' consumption at our average monthly rate of consumption in September and October, 1946."

Tin Metal

The Ministry of Supply has revised the licensing procedure for the acquisition of tin metal. Applications for licences to acquire tin metal will now only be granted if accompanied by the following *signed* declarations: 1. "We certify that the quantity requested on the accompanying application is needed to cover orders for our products, and that in the case of applications for virgin metal full allowance has been made for our expected intake of scrap." 2. "We certify that, in respect of tin metal, our existing stocks plus our outstanding purchases, plus the tonnage now being applied for, will not exceed four months' consumption at our average monthly rate of consumption in September and October, 1946."

The Minister of Labour and National Service has given notice that the limestone section of the quarrying industry will be withdrawn from the scope of the Essential Work Orders on or about March 31 next. Notices will be issued to individual undertakings to be de-scheduled.

Increased prices for lactic casein distributed by the Lactic Casein Importers' Association are announced by the Director of Sundry Materials, Board of Trade. The new prices, with effect from January 1, are: Mesh 90, £240 per ton; mesh 60, £235; mesh 30, £235; soluble, £245. For quantities of less than one ton these prices are increased by the equivalent of £5 per ton, and for quantities of less than one bag the rate is 5s. 3d. per kilo.

Maximum Selling Prices

Copper, Lead and Zinc

THE Control of Non-Ferrous Metals (No. 26) (Copper, Lead and Zinc) Order, 1946 (S.R. & O., 1946, 2205), revokes the Control of Non-Ferrous Metals (No. 25) (Copper, Lead and Zinc) Order and increases the maximum prices of copper, lead, zinc and zinc products as follows: Copper, by £19 per ton; lead, by £15 per ton; zinc, by £15 per ton; zinc sheets, by £15 per ton; zinc oxide, by £12 15s. per ton.

The price of high conductivity electro-copper is, therefore, increased from £98 to £117 per ton; of good soft pig lead (Empire and domestic) from £55 to £70 per ton; and of zinc (g.o.b. domestic and prime western) from £55 to £70 per ton. Prices for other forms of these metals are correspondingly adjusted. The price of zinc sheets is increased from £66 2s. 6d. to £81 2s. 6d. per ton ex-works, and for red seal zinc oxide from £56 to £68 15s. per ton delivered, with a similar increase for the other forms of zinc oxide.

The Ministry of Supply points out that the foregoing increases reflect the recent sharp upward movements in metal prices which have taken place outside the United Kingdom and which in turn affect the purchase prices paid by the Ministry. Holders of outstanding licences granted on or before December 31, 1946, will only be covered at the new prices now in force. The new Order further releases hot-rolled copper wire-rods from acquisition and disposal licensing.

New Factories Regulation

According to a new Dangerous Occurrences (Notification) Regulation dated January 7, 1947, the compulsory notification of occurrences covered by the 1935 order is now extended so as to cover factories as defined in the Factories Act of 1937.

Products which may now be imported into India from any country under Open General License VIII and therefore without individual licence include: Barks for tanning, excluding wattle bark; cutch and gambier, all sorts; olibanum and frankincense; gum arabic; gum benjamin (ras and cowrie) and dammer (including unrefined batu) and rosin; opium; cinchona bark. All sorts of animal fats, not otherwise specified, excluding stearine; beeswax; tallow; all sorts not otherwise specified, excluding wattle extract. Metallic ores, all sorts except antimony ore ochres, and other pigment ores. The following chemicals in packing exceeding 28 pounds for chemicals in substances and 1 Winchester quart for chemicals in liquid, namely: Formaldehyde and lime; boric and carbolic acids.

MANAGEMENT PROBLEMS

In order to assist subscribers in the solution of their management problems we invite questions relating to such matters as accounting, costing, control of plant and materials, office methods, income tax, etc. Correspondents will be answered under initials but should give their names and addresses which will not be published, and when documents of any kind are sent to us they should be copies only, as they cannot be returned. Letters should be addressed to the Editor.

Oil Drums and Barrels

Query.—" We use hundreds of oil drums, steel barrels and kegs, most of which are charged out to customers at nominal prices. We would like to institute a method of control over containers in general. If you have any suggestions to offer that would help us to maintain a check on stocks, we should be glad."—H. & D.

Reply.—Whether they are charged out to customers or not, the stocks of containers, including barrels, casks, drums, kegs, and tin boxes, etc., should be subjected to control, and the liability of buyers to pay for containers should be stated in definite terms on all invoices and debiting documents sent out. Some firms keep a register for recording the number of each size and description in stock, and replace all losses as soon as they occur, thereby carrying approximately the same numbers at all times. In the case of barrels and casks, identity numbers should be entered in the sales book or outwards book, and it is a good plan to keep separate accounts showing the commencing stocks, the purchases, the number lost, and the closing stocks—empty, full and with customers. By ruling a column in the day book, the number of containers sent out with each delivery can be inserted without clashing with other numbers or figures, and the number of containers returned by customers from time to time can be entered in a special column of the returns book, or at the end of the sales book. At the end of each month a list should be made out showing the number of containers in the possession of customers.

Water Softening Plant

Query.—" The water softening plant is shown in my accounts at £250 although in, say, four years' time I am perfectly certain that the actual value of the plant will be no more than £100. I have allowed for an expenditure of £30 for repairs and replacements during the year to June next, and anticipate that the cost of renewals of filters, etc., will be something like £40 in 1947-48, and perhaps £50 the following year, and so on. I am endeavouring to operate a system of budgetary control and I would like to be able to incorporate a constant figure to cover depreciation and upkeep. Could you show me how this can be done. At present I am applying the straightline method of depreciation, but, of course, this does not equalise the burden."—J.S.

Reply.—In order to equalise the combined charge for depreciation and upkeep it would be necessary to subject the water-softening plant account to a percentage deduction each year, the percentage being calculated on the diminished book value in each case. In the circumstances referred to, the rate should be 20 per cent. At the end of four years this would reduce the book value of the plant to £102 and at the same time spread the burden evenly over the period, as shown below :—

	Depreciation	Upkeep	Total
	£	£	£
First Year	50	30	80
Second Year	40	40	80
Third Year	32	50	82
Fourth Year	26	55	81
	£148	£175	£323

Query.—" In addition to an engineering shop we have a separate chemical manufacturing department controlled by a progress and planning system which is quite satisfactory apart from the control of orders. To enable us to become 100 per cent efficient would you detail a method of recording orders received by the manufacturing section."—L.A.

Reply.—Some manufactutrers set down the details on loose printed sheets forming part of a slip system, and retain the sheets in a folder or on a file until such time as the orders have been fulfilled, when the sheets are either placed on another file or bound in book form to constitute a kind of order book and sales book combined. There are, however, several drawbacks associated with the use of loose sheets or forms, some of which are almost bound to get lost or mislaid before the orders have been properly carried through, or before the full prices have been charged out. By keeping a duplicate book and writing out each order on the carbon-copy principle, the original can be handed to the person or transferred to the department immediately concerned, and the copy retained for reference purposes. When an order has been completed the charging price can be inserted in the duplicate book and debited direct to the respective account. As a rule, however, it is much better to use a special order book ruled with columns for showing the date on which each order was received, the order number, requirements, rate or price, date of completion, etc.

Metallurgical Section

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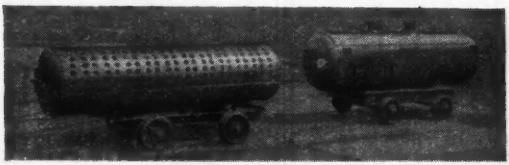

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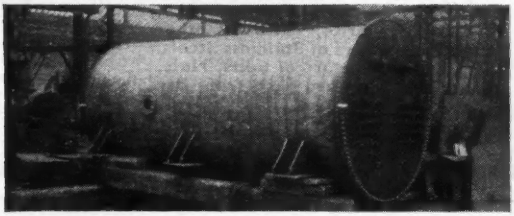

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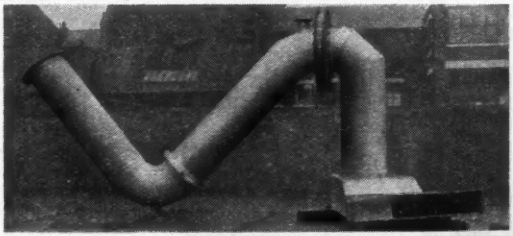

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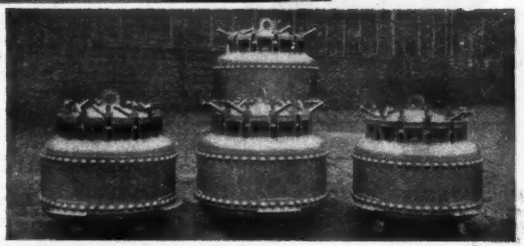

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Metallurgical Section

1 February, 1947

Trends in Powder Metallurgy—II

by W. G. CASS

ON the subject of limitations, with which the previous article ended (THE CHEMICAL AGE, January 4, 1947, pp. 5-10)* it appears that Chase[1] is definitely of opinion that the lower density and general grain structure of meal powder compacts is such as to affect adversely the yield strength, ductility, and impact strength, as compared with wrought metal in many cases. It is, of course, very difficult to generalise as to the comparative values of the various processes, and each case has to be judged on its merits in the light of the special conditions and requirements involved.

Americans Ahead

In regard to mechanical properties, as H. W. Greenwood (of Powder Metallurgy, Ltd.), has pointed out in a lecture (*see* also *Met. Ind.*, 1945, June 8, p. 354), great advances have been made in recent years; and limitations in these or other properties become of less importance every year. He would indeed be a bold man who would fix definite limits to the possibilities inherent in this technique. Improvements are constantly being made in the design of presses, sintering furnaces, and other apparatus.[2]

But the view is still widely held that the Americans are ahead of us in this particular field, at least as regards mass production and handling large pieces; and it is evident from the American technical press and still more from the symposium of papers edited by John Wulff, to which reference has already been made, that a large number of firms and research organisations are devoting much time and money to the further development of powder metallurgy. But some progress is being made over here also, and many important firms, some of them in fact pioneers and leaders, are devoting more attention both to practical applications and to the fundamental scientific basis of this most interesting branch of industry. Among these are Murex, Ltd.; G.E.C.; British Piston Ring Co., Ltd.; Johnson, Matthey & Co., Ltd.; Manganese Bronze Co.; Mallory Metallurgical Co., Ltd.; and many others. Yet there is still wide scope for further developments in this country, both in the production, testing, and standardisation of metal powders and in the various operations of compacting them; and probably still more scope in their varied and manifold applications. Though these latter hitherto have been mainly of interest to engineers, there should be many opportunities for extension in the chemical industries.

There are in fact two or three aspects of powder metallurgy which should be of particular interest to chemists, apart from the use of metal powders in the production of filters and other apparatus, strong resistant alloys and refractories. By way of example, one may cite metallic hydrides and metal catalysts. The recent work done by powder metallurgists on particle size control is also of considerable interest to chemists. And the many outstanding questions and problems yet to be solved will in many cases concern the physical chemist more than anyone else. Some of these will be briefly noted later.

Interest in Metallic Hydrides

It is hardly necessary to emphasise the growing interest in metallic hydrides. If only as a source of absolutely pure hydrogen, in the nascent state and therefore more active, they would be of considerable value; but they have other interesting properties. Among the symposium papers published by the American Society of Metals is one by P. P. Alexander, of Metal Hydrides, Inc., on the hydride process and its products (Chap. 12, pp. 145-154). Actually the paper deals solely with the products and not at all with the process.

Some elements such as lithium and sodium form only one compound with hydrogen, while others combine in more than one pro-

* The author is indebted to correspondents for one or two suggested amendments in previous article. In the first place, it was not intended to create the impression that powder metallurgy is unduly competitive with other methods. It is, in fact, more complementary than competitive. Again, hot pressing is by no means the only or even the most important operation: there are others. Tungsten carbide is seldom if ever used for electric contacts, valve seats, etc., but mainly for cutting tools, wire-drawing dies, and other wear-resisting parts. Finally, abrasives should not, of course, have been included among machine tools.

[1] *Mat. & Meth.*, 1946, Aug., 363-9.

[2] See also H. W. Greenwood on the "Practice of Powder Metallurgy," *Met. Ind.*, 1942, 60, 77-79, 112-14; 61, 226-7, 279-81; and E. S. Patch, on "Limitations of Metal Powers," *Met. Ind.*, 1941, 58, 212-14.

portion, so that the total number is considerable. They are definitely chemical compounds with widely differing properties from those of the metal, and are not merely metals containing occluded hydrogen. One most useful property is that, when heated, they dissociate into pure hydrogen and pure metal. Such non-volatile hydrides as TiH_2, for example, can therefore be used as a storage and generator of the 100 per cent pure hydrogen often required in the chemical or metallurgical laboratory.

The hydrides can also be used in the production of alloys difficult to prepare by other methods. Those of the fourth and fifth periodic groups (TiH_2, ZrH_2, HfH_2, ThH_4, CbH and TaH) are stable at room temperature, non-hygroscopic, and can be preserved in air indefinitely without risk of oxidation. They are produced as fine powder of 300 mesh or finer, and look exactly like the original metals. When heated in a vacuum, or a non-oxidising atmosphere above 350°C. they gradually dissociate, most of the hydrogen being expelled at a bright red heat. If, however, they are heated in air above 350°C. the hydrogen will burn, and the envelope of burning hydrogen prevents further access of air, so that the burning proceeds very slowly. As with all finely powdered material or dust, precautions must be taken against fire and with some hydrides also against explosions.

Stability of Hydrides

From the point of view of safety the hydrides, except that of thorium, are more stable than the degassed powdered metals. They can be ball-milled, stored dry, dried in air at 100°C. and otherwise handled with less danger of combustion. The hydrides of boron and silicon—forming with hydrogen an homologous series of compounds—require greater care in production and handling. Temperature of dissociation varies widely: boron hydride dissociates at room temperature with explosive violence; while thorium hydride also requires care in handling. Tantalum hydride, on the contrary, is not completely dissociated below a temperature of 1200° C. The most useful, however, are those of the titanium group.

Titanium, the ninth most abundant element in the earth's crust, has a specific gravity of only 4.5, a melting point above that of platinum and, in small additions of 1-3 per cent to copper or nickel, forms valuable alloys. It is very resistant to acids, and in the pure state is quite ductile. It alloys readily with most metals, and also forms extremely hard carbides and nitrides. It is now produced in the form of a fine powder which can be easily compressed into suitable forms and sintered at 900-1000°C. Another valuable property is that of spreading, at temperatures of about 900°C., over the surface of copper in a thin layer, like oil over water, forming a titanium-copper eutectic alloy of much greater hardness than copper. It can be thus applied to other metals through the intermediary of copper. Alexander describes the coating method together with some simple tests to determine its feasibility or otherwise in particular cases. In regard to the Ti-Cu alloys in general, he adds that there are now several master alloys available with Ti content ranging from 15 per cent to over 60 per cent. The standard alloy of this class contains 27-30 per cent Ti. It has a white silver-like colour, is quite resistant to oxidation, and although fairly hard is yet sufficiently brittle to be easily pulverised to powder of 200-300 mesh.

Zirconium, too, is produced in fine powder, 300-500 mesh, in two grades: A, practically free from occluded gas; and when in such pure metallic state it can only be stored or transported in a moist condition, like titanium. Grade H is ZrH_2 and contains 1.5-2 per cent hydrogen. Hydrogen is evolved if heated above 300°C. and is of a similar value to that from titanium hydride. Zr is a comparatively light metal, with specific gravity of 6.4, a high melting point of 1700°C., and very ductile in the pure state. One of its most important properties is probably that of forming an age-hardening alloy with copper of varied composition; that preferred for ladle additions contains about 35 per cent Zr. Its principal ores are baddelevite (ZrO_2) and zircon ($ZrSiO_4$).

Rare Metals

Besides Ti and Zr, other metals such as Th, U, Va, Cr and W may be similarly produced as fine powders of 200-500 mesh and of high purity, up to 99.5 per cent or more. Uranium like thorium requires special care in handling. In fact, wherever possible, it is better to use alloys instead of pure metal, not only for safety but also on account of higher tensile strength, hardness, and greater resistance to oxidation and corrosion. With some alloys, like that of Cr and Co, for example, their preparation from the pure metals presents difficulty owing to risk of oxidation, and the hydride process offers advantages in this respect. It yields powdered materials which can be treated by the standard methods of powder metallurgy. The powdered alloys are made directly from the corresponding oxides in the form of fine powder of 100-400 mesh without grinding or other mechanical operation.

Although powdered metals and alloys, in view of their peculiar properties, large surface area, chemical reactivity, etc., must be of increasingly wide and varied interest to the chemist in many ways, it is probable that the most interesting use at the moment is in catalysis. In his paper on metallic catalysts—in the symposium—P. H. Emmett, of Johns Hopkins University, asks: (a) Will

catalysts prepared by powder technique be as active as those now used? (b) What special catalytic properties of metals will have to be considered? The author attempts at least a partial answer with a brief summary of factors governing catalyst activity, methods used in preparation of metallic catalysts, and special properties of various metals in chemical reactions (*loc. cit.*, Ch. 13, pp. 155-165, 26 refs.).

Governing Factors

As to the first, governing factors, these are mainly surface area, specificity, sensitivity to poisons and promoters, and active points qualifying the significance of surface area. On the subject of preparation the author presents the following useful table which shows typical uses and principal methods of preparation:

Method	*Typical metal so prepared*	*Example of use*
1. Gaseous reduction of compounds	Ni, Co, Fe, Cu	Hydro- and dehydrogenation.
2. Gaseous reduction of fused oxides	Ni, Co, Fe, Cu	Ammonia synthesis over Fe; CO-H_2O reaction over Co-Cu.
3. Precipitation of metal in solution by reducing gases or dissolved substances	Ni, Co, Fe, Pt, Pd ...	Hydrogenation of oils (fatty) with Ni, etc.
4. Carbonyl decomposition	Ni, Fe, Co	Liquid phase hydrogenation.
5. Gauze or foil	Pt, Cu	Ammonia oxidation (Pt). Methanol oxidation (Cu).
6. Thin oriented metal film	Pt, Ni, Fe	Hydrogenation (in lab. stage).
7. Metal rods or filings	Ni	High temp. dehydrogenation of methane, etc.
8. Alkali removal of Al from alloy	Raney Ni	Liquid phase hydrogenation.
9. Decomposition of amalgam	Fe, Ni	Hydrogenation (in lab. stage).
10. Pressed metal powder	Ni, Pt, Fe	—

(The first four may be either supported or unsupported; the last six are usually unsupported. The compressed powdered iron catalyst in the last example dates back to a comparatively old German patent, No. 484778 of König.)

The table, of course, refers only to those cases where the catalyst remains essentially metallic. The large class of reactions in which oxides or salts are formed are necessarily excluded.

The symposium contains several papers on particle size:

Ch. 15 (pp. 173-181) on particle size determination for control of tungsten products, by Morgan F. Rogers, of Tungsten Electric Corp., describes two sedimentation tests based on Stokes' law which proved more satisfactory than microscopic methods. Author used Wetanol (Glyco Products Co.) and glycerine as settling media.

Ch. 16 (pp. 182-5) on effect of particle size on microstructure of cemented tungsten carbide, by same author. The electron microscope was used and micro-photographs of 500 to 14,000 dia. are shown. Carburisation, effect of cobalt binder, etc., are discussed.

Ch. 17 (pp. 186-215) on laboratory sizing, by R. Schuhmann Jr., of Mass., Inst. of Technology, 54 refs. Methods are described and mathematically treated for (a) preparing fractions of uniform size, (b) measuring particle size distribution, and (c) estimating specific surface of powders. Sedimentation methods are described under (I) Fractionation-sedimentation and decantation, elutriation in liquid or air; and (II) Non-fractionation-pipette, hydrometer, turbidimeter and sedimentation balance. Also sieving and microscope sizing.

Ch. 18 (pp. 216-220) on microscopic particle size determination, by Chas. R. Rogers, Metals Refining Co., Division of Glidden Co., gives outline of author's way of making a count and expressing it in terms of weight, volume and surface.

Ch. 19 (pp. 221-233) on determination of surface area and average particle size of finely divided metals by use of low temperature adsorption isotherms. P. H. Emmett, Dept. of Chemical and Gas Engineering, Johns Hopkins University, 21 refs.

Ch. 20 (pp. 234-243) on the electron microscope as metallurgical tool, by G. G. Harvey Mass. Inst. Technology.

Dr. W. D. Jones some ten years ago indicated a large number of very interesting questions and outstanding problems in powder metallurgy requiring further investigation. Many of them appear to be of a nature which involves the kind of fundamental or pure scientific research which individual firms pre-occupied with the practical applications of powder metallurgy and more or less routine problems have not the time or the staff to handle. But no doubt the D.S.I.R. and other appropriate bodies are well aware of the position and will take or are taking such steps as are necessary to enable this country to take a leading position in this important field of research. We shall hope to learn a little more of recent progress in this country, concerning which it is difficult to obtain reliable information, at the forthcoming symposium on powder metallurgy which is being held this year under the joint auspices of the Iron and Steel Institute and the Institute of Metals. Meantime the writer has been told by those well qualified to express an opinion that Dr. Jones' list of outstanding queries, instead of decreasing during the past decade, has grown considerably.

Metallic Cohesion

The following is a brief summary of those items in the list which may be of particular interest to chemists; and it is hoped that,

although stated baldly without the context, they will be intelligible. On the subject of metallic cohesion, we need to know more about the effect of very low temperature, and of gases, and of the relation between bimetallic adhesion and chemical affinity. More quantitative experiments on cohesion in metallic bodies are wanted; and in connection with sintering much remains to be done as to effect of time, temperature, pressure, gas or oxide films. As to the volume effect of gases and vapours, possible sources of gas are numerous, while very little is known of the totals that may be formed or are present. In the extensive work still to be done on cold pressing—for this still remains in the field despite the progress with hot pressing—it will be necessary to include study of the real value or significance of the Brinell test. No work has yet been done on shrinkage from the point of view of surface tension, and the measurement of surface tension of solid metals is as yet insufficiently advanced. Peculiar behaviour of powdered metal compacts in regard to mechanical properties, and age hardening are still unexplored; as also is a large part of the subject of diffusion.

Tests, standards, and specifications are another important branch of the subject on which much work is now being done. Particle size, flow factor, loading weight or apparent density (gm./c.c.) and other powder factors, as well as density and porosity, mechanical and electrical properties, shrinkage, etc., in compressed compacts, must be easily and reliably determined and reduced to routine practice as much as possible.

Precipitation Hardening

by L. SANDERSON

PRECIPITATION hardening may be termed the hardening effect produced in a metal by the precipitation of a phase from the solid solution. It was first observed in 1911 in connection with duralumin, and although it has been studied intensively since that date, there is still much that is obscure and much of purely theoretical character in regard to it. The present article confines itself to a summary of the theory of the process, and an indication of its practical employment as a means of producing specific effects in metals.

Essential Requirements

In the first place it is necessary to consider what requirements must be fulfilled before a material can age- or temper-harden, i.e., become harder at either normal or elevated temperatures as a result of unimposed modifications of its structure. One such requirement is fulfilled when a constituent which is more readily dissolved at an elevated than a low temperature is compulsorily maintained in solid solution by quenching, followed by a later precipitation of this phase. Such a condition is characterised by the reaction:

supersaturated $\alpha \rightarrow$ saturated $\alpha + \beta$.

Another instance is when a eutectoid change is prevented by quenching with a later heating. The transformation associated with the precipitation of the dissolved phase produces higher hardness. The reaction in this case is shown by $\alpha^1 \rightarrow \alpha + \beta$.

The third example is the additional hardness sometimes acquired by an alloy which has been chilled quickly enough to suppress its normal change from disorder to order, and then raised to a temperature sufficient to allow of the change. This reaction is represented by $\beta^1 \rightarrow \beta$.

The second of these examples is experienced most commonly with the aluminium-zinc, iron-carbon, copper-tin and aluminium-copper alloys. The third is more evident with the copper-zinc and gold-copper alloys. With this third instance we need not concern ourselves because of its lack of commercial significance.

It has been explained that if precipitation hardening results from some modification of phase, the equilibrium diagram must reveal either a considerable reduction in solid solubility together with a reduction in temperature, or a eutectoid transformation. Assuming that the normal form of solvus curve is shown, it will be found that when the material is quenched from a point above the upper limit of solubility, the excess phase is kept in solid solution. This means that a temperature exists at which the unstable supersaturated solid solution developed by the quenching operation will return to a stable state, and the extent of the change will be governed by the temperature.

Stability Hardening

How far the material is hardened by the return to stability, i.e., precipitation of the excess phase, depends on the character of the transformation and on the quantity of the phase that can be kept. The more closely the composition of the material approximates to the upper limit of solubility, the greater will be the hardness produced. It should be noted that if the composition goes above the upper limit of solubility, there will be no marked increase in hardness, but the material will be less ductile.

By introducing additional alloys into the composition of the material it becomes possible to modify the hardness, but the extent to which this occurs depends primarily on the extent to which the solid solubility of the excess phase is raised or diminished. As a rule the new intermetallic phases are insoluble, so that in respect of precipitation hardening their effect, if they constitute a new phase, is negative.

Should the equilibrium diagram indicate a eutectoid, there are two possible causes of precipitation hardening, namely, decomposition of β into $\alpha + \gamma$ or separation of γ from quenched α (α^1). It is also possible for the eutectoid transformation to be found in combination with an allotropic modification, e.g., in the iron-carbon system, in which case the precipitation hardening may result from either (a) breaking up of γ into α + an intermetallic compound Fe_3C; or (b) separation of the intermetallic compound from α (Fe_3C from α iron).

Many alloys contain small percentages of elements which have been introduced for purposes of deoxidation, or to give greater fluidity of the alloy, easier machining, and grain refinement. Such alloys have extremely complicated systems, and it is not easy to produce a complete equilibrium diagram. Consequently, to determine in advance the likelihood of precipitation hardening, it becomes necessary to have recourse to other measures, among which may be mentioned tests of hardness.

Heat Treatment

From the above it should be evident that where the alloy in consideration is liable to precipitation hardening, it can be given a carefully worked out and accurate heat treatment designed to produce the desired result. Such a heat treatment comprises first a high temperature solution treatment designed to homogenise the material. The temperature chosen should correspond to that of the greatest possible solid solubility of the phase that produces the precipitation hardening. Secondly, a quenching should follow for the purpose of maintaining at normal temperature the structural condition produced by the high temperature. In other words, the high temperature structure is "frozen," or perhaps artificially preserved would be the better phrase. Next should come a tempering at a relatively low temperature for the purpose of ageing or precipitating out the excess phase, with hardening of the material as a result. Broadly, the hardness will develop more quickly in proportion as the tempering temperature increases.

A peculiar characteristic of the precipitation-hardening alloys is the effect upon their hardness of mechanical working and strain. Strain results in a distortion of the atomic lattice structure, and appears to increase the rate at which precipitation occurs in these alloys. The explanation is that diffusion seems to take place more easily in a distorted atomic lattice structure. Even quenching strains have been proved to heighten noticeably the speed of precipitation. The effect of mechanical working of quenched material is said to develop a strain-effect upon the structure comparable to that produced by a low temperature ageing treatment. At the same time the two effects are not exactly the same, and it is arguable that the test results on which these observations are based are not of general application.

So far as the commercial alloys of precipitation hardening type are concerned, it is truer to say that mechanical working results in a degree of work-hardening combined with a general quickening-up of the preliminary phases of ageing. It also brings the alloy more quickly to that point at which additional hardening becomes slow. Finally, mechanical working lowers the increase in hardness following upon ageing, and produces a somewhat higher hardness in the end.

Taking any particular alloy, it is known that the higher the degree of supersaturation of the solid solution, the greater is the increase in properties that results. For this reason there should be as little difference as possible between the maximum solubility temperature and the solution treatment temperature, while taking every precaution to avoid overheating of the material or its spoiling by excessive temperature. It is reasonable to assert that the solution treatment temperature should be as high as possible, but can if desired be modified within a small temperature range.

Quenching Medium

The choice of quenching medium is of importance only in so far as slightly improved mechanical properties are obtained from a cold water quench, but at the same time resistance to corrosion is impaired. Boiling water appears to be better, at all events for the higher qualities of aluminium alloys, as regards corrosion resistance, and only slightly inferior in mechanical properties conferred. The tempering temperature causes the alloy to acquire its highest hardness more quickly in proportion as it is increased, and also lowers the maximum hardness obtained by any alloy. Consequently, higher tempering temperatures have an effect resembling that of mechanical working following on quenching.

It is known that when a metal is cooled and an arrest point exists, this point represents a liberation of energy, usually in the form of heat. For the nuclei serving as the focus of precipitation to be developed in a solid, energy is required, and if the nuclei are to be stable, this energy must be equal to that developed by the change of phase

corresponding to the arrest point on cooling.

The superficial area of a nucleus declines as the square of the diameter, while the volume diminishes as the cube of the diameter. In other words, where the nuclei are small, they have a comparatively high ratio of superficial area to volume. As the number of atoms in the nucleus determines the total heat released, the volume, decided by the number of atoms in the nucleus, has to be adequate to provide the energy on which its surface depends. In consequence the nucleus must at least be large enough for stability to be obtained, combined with a resistance to dissolution. The maximum stability of the smaller nuclei is achieved at lower temperature because the energy set free as the result of a change of phase is greater at lower degrees of supercooling.

Formation of Nuclei

The formation of nuclei in a solid solution is restricted by the rapidity with which the atoms constituting the precipitate disperse. For the fastest rate of nucleus formation, which is found at low temperatures, the dispersion is slow, and therefore it is not so easy for nuclei to be created. In consequence, since these are conflicting tendencies, nuclei will develop most rapidly at some specific temperature. Formation of nuclei is slower at the higher temperatures by reason of the fact that the type of stable nucleus desirable must be of larger dimensions, and at the lower temperatures by reason of the relatively slow dispersion. As temperatures decline, the stable nucleus will become smaller until, eventually, it is itself no larger or little larger than an atom.

The extent to which precipitation will occur about these nuclei is governed by the structural condition of the alloy. Particles will grow in consequence of the liberated energy declining as a result of precipitation, combined with the relief of supersaturation in the matrix. Minimum energy is demanded for precipitation at the crystal boundaries and crystallographic planes. As a result, the precipitate normally occurs at the crystal boundaries, or as a Widmanstatten structure, or as a fine regular precipitate. Increase of quenching temperature results in higher rate of precipitation, and the relation between these two factors can be expressed by a formula: $\frac{S_1}{S_2} = 2^{\frac{\theta - \theta_2}{I}}$

In this formula, S_1 and S_2 refer to the speeds at temperatures θ and θ_2, while I is the temperature interval during which the reaction speed doubles.

How fast the particles grow is governed by the rate of diffusion of the solute to the precipitate particles and its variation as the solute concentration diminishes. An essential requirement for the growth of particles is a diffusion of the solute from an impoverished to a richer area. Moreover, if growth is to go on, it is inevitable that the minimum condition of liberated energy will be found as a result of the transformation of the high energy corners of the crystals and their edges into spheres, and of the reduction in the total areas of their interfaces. In this way the particles become spheroidised and clotted together.

The theory at present reigning is that the quickening up of precipitation hardening by mechanical working in the cold condition results from an enforced reduction in diffusion.

It must be appreciated that the precipitate forming in alloys of the precipitation hardening type does not always appear in the same manner, and for this reason it is advisable to group the alloys according to the manner in which the precipitate occurs. There are four main groups: the ideal, the continuous-general, the continuous-localised, and the discontinuous.

Of these, the first gives an even distribution of the precipitate, together with a uniform, uninterrupted lowering of solute concentration in the matrix. The second, of which the aluminium-copper alloys represent an example, shows an even distribution of the precipitate, and an uninterrupted, but not uniform, lowering of solute concentration. The third shows an uneven distribution of the precipitate, which tends to occur at the crystal boundaries and slip planes, while the solute concentration is lowered continuously in limited areas, but discontinuously as a whole. Lastly, the precipitate is distributed unevenly, and tends to occur at the crystal boundaries, while the solute concentration is discontinuously lowered.

(To be continued.)

A New Zinc Refinery

A zinc refinery, capable of producing 100 tons of special high-grade zinc a day, and 70,000 tons of sulphuric acid a year, plus cadmium, will be built at Arvida, Quebec. The cost, including working capital, will be $10,500,000 and the plant is to be in production in the spring of 1948.

Zinc and Manganese Deposits

Wartime investigation of zinc and manganese deposits in the western and south-western sections of the United States are described in separate Bureau of Mines publications now being released. The publications are as follows:

Report of Investigations 3962: "Exploration of Silver Eagle Zinc Deposit, Hudspeth County, Tex." 3958: "Exploration of the Mohawk Zinc Prospect, Pima County, Ariz." 3969: "Exploration of Contact Manganese Mine, Grant County, N. Mex."

Allocations of Tin Metal

THE Ministry of Supply announces that at a recent meeting in Washington of the Combined Tin Committee it was recommended that, in view of statistical uncertainties regarding the supply position but having regard to the need to keep supplies moving, only interim allocations of tin metal for the first half of 1947 should be made at present amounting to approximately 50 per cent of the allocations recommended for the last half of 1946. These interim allocations (which do not include domestic production) are not to be regarded as constituting a pattern for final allocations. At a later date substantial additional quantities of tin will be available for allocation.

During the first half of this year the interim allocations are as follows—figures in long tons: U.S.A., 3640; France, 2275 India, 1140; Canada, 680; Italy, 455; Sweden, 390; Switzerland, 365 Czechoslovakia, 340; Poland, 205; New Zealand, 150; Hong Kong, 150; Denmark, 140; Austria, 115; Brazil, 115; Argentina, 100; Turkey, 100; Egypt, 100; other Middle East including Palestine, 100; Yugoslavia, 90; other Latin America, 80; Finland, 70; Norway, 70; Greece, 45—Total, 10,915.

In general, supplies may be obtained from the following sources: United Kingdom on behalf of Malaya and Hong Kong; the Netherlands including Netherlands East Indies; Belgium including the Belgian Congo; China, Siam and South Africa. For the Latin American countries the United States is an additional source for limited quantities and supplies may be available to France from French Indo-China. There is doubt whether Siam can be regarded as an effective source, owing to exchange difficulties; and for the present, owing to the need for inspection, no further quantities are available from Japanese stocks in the United States.

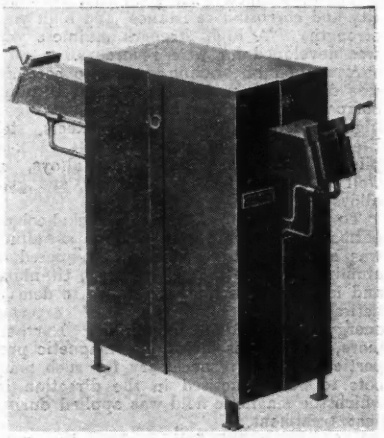
Aluminium Colour Process

THE prospect of considerably widened use of aluminium, notably in the manufacture of decorative goods, is suggested by the development and application by Altone, Ltd., Glasgow, of a method of aluminium anodisation, to which ten years of research have been devoted, which permits the production of aluminium and its alloys with a wide range of attractive colour finishes. No details of the process are as yet available, beyond the fact that it is a development of aluminium anodising. It is controlled, however, to permit the mass production of designs to a standard pattern and is a combination of printing and plating. The process is expected to have a major application in fields where materials previously used were found to be fragile.

New Box Furnace

High Automatically-Controlled Temperatures

A NEW box furnace designed to meet modern laboratory requirements for high, automatically-controlled temperatures, suitable for operation up to 3100°F., has been announced by the Industrial Heating Division of the (U.S.) General Electric Company. The new furnace can be used in such applications as melting and bright annealing of metals, sintering of powdered metals, reduction of metallic oxides, ceramic firing, copper and silver alloy brazing of metals, but, because the heating units must be protected against oxidation, the furnace is limited to operations which can be performed in a protective atmosphere.



The heating units—molybdenum rods—are rated at 20 kW 65 volts single-phase at 3100°F. The heating chamber is 4 in. by 4½ in. by 25 in. long. A standard type temperature control instrument mounted on an operator's panel provides automatic temperature control.

The July and August issues of *Philips' Technical Review*, published by Philips' Lamps, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, and obtainable from their publicity department (2s., post free), have reached us. Authoritative technical articles covering a range of the firm's most interesting products are included. One article describes the receiver of an experimental carrier-wave telephone link, on ultra-short-waves with frequency modulation, between the Philips' works at Eindhoven and Tilborg in Holland.

G.E.C. REVIEW OF 1946

From Our New York Correspondent

REVIEWING its 1946 activities, Guy Bartlett on behalf of the General Electric Company reported that the year was one of much progress in the electrical manufacturing industry and said that progress was, for the most part, in application engineering, in design engineering, and in fundamental research.

Metallurgical research, the company reports, produced several new materials and methods during the year and was responsible for many advances in current projects. Among the new alloys were aluminium-copper-beryllium cast and precipitation-hardening alloys of unusually high tensile strength, coupled with good thermal stability and corrosion resistance, and high yield strength. A high strength stainless wire was developed for wire recorders.

A method of brazing metals to ceramics was developed, using a coating of titanium compound on the ceramics. The brazing of high-chromium alloys—stainless steels, stellite, vitallium and the like—was accomplished with nickel-manganese alloys, as well as with copper, silver alloys, and gold alloys.

To the series of alumium-nickel-cobalt permanent magnet alloys known as alnico was added another, Alnico 6, composed of aluminium, nickel, cobalt, copper, titanium, and iron. It has high resistance to demagnetisation, and high values of external energy and residual induction. Furthermore, it possesses directional magnetic properties, making it necessary for such magnets to be magnetised in the direction in which the magnetic field was applied during heat treatment.

Vectollite is the first non-metallic, non-conducting magnet material ever made. It is a hardened, sintered combination of iron oxide and cobalt oxide. The magnets, being non-metallic, are extremely light, and their non-conductive properties prevent electrical losses caused by current conduction.

Reviewing its chemical research activities, the company reported that a newly-developed X-ray photometer promises to have many physical and chemical applications, and to make possible for the first time the widespread use of the great advantage inherent in X-rays as contrasted to other forms of radiation. Outstanding among these advantages is the fact that the X-ray absorption of a sample does not change with its physical state nor with the chemical state of the elements (free or combined) which it contains.

In the field of chemical industries, the reconversion to peace-time purposes very largely occupied the attention of the electrochemical industries, with chlorine production receiving much emphasis. Several ignitron assemblies were installed, as well as about 275,000 kVa in steam-turbine generating capacity.

The company's activities with relation to plastics and silicones revealed several new developments. A new type of plastics compound was produced for making air-tight, water-tight seals. As caps and sleeves they are being used on air-conditioning and refrigerating equipment to close open tubes before installation, and as lead markers on wires and cables, as insulation covering for bus-bars and wire cleats, and for electrical insulation of wrench and other tool grips. The caps and sleeves, produced dry, are soaked in a dilator solution before use and upon drying they shrink to smaller than normal size to form a tight fit.

One of the year's most interesting announcements about silicone products was that a silicone paint, under development, indefinitely retains its original colour and gloss. Surface finishes of automobiles, electric ranges and hospital equipment, are expected to be among the chief applications. From other quarters your correspondent has received reports stating that silicone paints have been developed to the point where they will outlast the material to which they are applied.

Silicone rubber, because of its heat-resisting qualities and flexibility at extremely high and low temperatures, found increasingly wide applications in industrial fields. As gaskets for drying and baking ovens, for example, it outlasts ordinary rubber or rubber-asbestos compounds now commonly used.

Finally, in the field of oils and greases there was the development of silicones in filling compounds and putties of permanent consistency, including even tacky grease compounds which adhere and do not flow.

A report from Chile states that the bay workers at Tocopilla—the principal nitrate port in Chile—who went on strike last October have returned to work, thus ending a strike which has been one of the worst labour disputes affecting the nitrate industry in recent years.

The Tacoma aluminium reduction plant has been handed over from the U.S. Government to the General Construction Company of Seattle, belonging to the Kaiser organisation, which also owns the Baton Rouge aluminium plant, Oakland.

NEXT WEEK'S EVENTS

MONDAY, FEBRUARY 3

Oil and Colour Chemists' Association, Hull Section. Royal Station Hotel, 6.30 p.m. Mr. F. A. Walker, A.R.I.C.: "Dyestuff Pigments for Paints."

Society of Chemical Industry, London Section. Burlington House, London, W.1. Joint meeting with Food Group. Dr. Ezer Griffiths, F.R.S., and Mr. F. R. Jones, M.Sc., F.R.I.C.: "Refrigeration: Development and Application."

TUESDAY, FEBRUARY 4

Institution of Chemical Engineers and the **Society of Chemical Industry** (Road and Building Materials Group). Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W. Conference on Particle Size Analysis. 10 a.m.-12.30 p.m.: Methods of Measurement; 2 p.m.-5 p.m.: Industrial Applications.

Hull Chemical and Engineering Society. Church Institute, Albion Street, 7.30 p.m. Dr. W. C. Gilpin, Ph.D., A.R.C.S.: "Magnesia from Sea Water."

Royal Institute of Chemistry of Great Britain and Ireland, Belfast and District Section. Queen's University, 7.30 p.m. Mr. Ronald Belcher, F.R.I.C. (Sheffield) and Dr. Cecil L. Wilson, M.Sc., Ph.D., F.R.I.C.: "Methods and Apparatus in Inorganic Microchemistry."

WEDNESDAY, FEBRUARY 5

Society of Public Analysts. Chemical Society's Rooms, Burlington House, London, W.1, 6 p.m. Mrs. Erica Glynn: "Reductometric Determination of the Sulphoxide and Amine Oxide Groups" Mr. W. P. Thistlethwaite: "The Determination of the Composition and Constitution of Ammonium Phosphomolybdate and the Conditions Affecting its Precipitation."

THURSDAY, FEBRUARY 6

Chemical Society. Burlington House, London, W.1, 7.30 p.m. Dr. A. E. Alexander, B.Sc., Ph.D.: "The Application of Surface Chemistry to Colloidal Problems" (Tilden Lecture).

Royal Society of Arts. John Adam Street, Adelphi, London, W.C.2, 11 a.m. Conference on Proposed International Exhibition in 1951.

Textile Institute. Blackburn Chamber of Commerce, 7.15 p.m. Mr. H. Ashton, F.T.I. (Courtaulds, Ltd.): "Current Developments in Rayon Staple Spinning."

FRIDAY, FEBRUARY 7

Textile Institute. Dublin Mansion House, 7.30 p.m. Mr. E. Waters, B.Sc. (I.C.I., Ltd.): "Nylon Textiles—Their Properties and Processing."

German Technical Reports:

LATEST technical reports from the Intelligence Committee in Germany include those detailed below, copies of which are obtainable from H.M. Stationery Offices at the prices quoted.

BIOS 628. Investigations of the German paint industry (11s.).

BIOS 729. German aluminium and bronze flake powder industry (25s.).

BIOS 783. *Manufactures at Hiag, Mainz-Mombach*: Particularly acetone cyanhydrin, acrolein and acetonitrile (2s.)

BIOS 784. Interrogation of Dr. Gross, Professor Flury and Dr. Wirth on industrial hygiene and toxicology (2s.).

BIOS 788. German vitreous enamel industry (5s.).

BIOS 828. Textile waste reclamation (wool, rayon) (1s.).

BIOS 921. Hydrogen peroxide and sodium perborate. Interrogation of Dr. Baerwind at Beltane Schools, Wimbledon (6d.).

BIOS 927. Vinyl chloride, vinyl polymers and copolymers. Interrogation of Dr. Carl Wulff at Beltane Schools, Wimbledon (6d.).

BIOS 934. *Emschergenessenschaft, Essen*: Phenol recovery (1s.).

BIOS 938. *Lurgi Gesellschaft für Waermetchnik, Franfurt A/Main*: Dephenolation and carbonisation (1s.).

BIOS 942. *Gesellschaft für Teerverwertung, Castrop-Rauxel*: Tar distillation (1s.).

BIOS 949. Investigation of cast basalt (6d.).

BIOS 950. *Interview with Dr. Bachle of the Latex Laboratories of the I.G. Farbendustrie, Leverkusen*: Synthetic rubber latices (1s.).

BIOS 959. *I.G. Farbenindustrie*: Manufacture of triphenylmethane dyestuffs and intermediates at Ludwigshafen and Höchst (9s.).

BIOS 961. German dyestuffs and dyestuffs intermediates. Azo and lake dyestuffs (15s.).

FIAT 718. *I.G. Farbenindustrie, Leuna and Piesteritz*: Fertilisers (5s.).

Personal Notes

MR. M. H. FERGUSON has been appointed director of Calico Printers' Association, Ltd., Manchester.

MR. J. B. BENNETT, A.C.A., has taken up his duties as secretary of Rothamsted Experimental Station, in place of the late Mr. W. Barnicot.

PROFESSOR R. DELABY, General Secretary of the *Union Internationale de Chimie*, is president-elect of the *Société Chimique de France*.

DR. C. M. A. STINE, a director of E. I. du Pont de Nemours and Co., Inc., has been elected president of the American Institute of Chemical Engineers.

MR. H. P. COLES has been released by the Board of Trade from his post as Director of Molasses and Industrial Alcohol; and MR. H. N. GRUNDY, C.B.E., has been appointed to succeed him.

MR. J. B. LONGMUIR, M.B.E., formerly welfare officer to the chemicals firm of Newton, Chambers & Co., Ltd., has been appointed director of welfare by the National Coal Board.

MR. ANDREW MCCULLOCH, chairman from 1935 to 1937 and formerly honorary secretary of Manchester section of the Society of Chemical Industry, has resigned his Lectureship in Fuels at Manchester University and is *en route* for Canada to become chief research engineer under the Research Council of Alberta University.

MR. M. MCDOUGALL is to replace Mr. Douglas Campbell as British member of the Combined Tin Committee in Washington, upon Mr. Campbell's return to England. Consequent upon the return to England of Mr. J. A. E. Smart, secretary of the committee, Miss Marion Worthing and Mr. C. B. Wilson have been appointed joint secretaries.

DR. A. H. TENNEY has returned to the New York offices of Carbide and Carbon Chemicals Corporation as a technical representative for the Fine Chemicals Division, specialising in development of markets for new chemicals being developed by the research department. Previously associated with the Corporation in a sales development capacity, Dr. Tenney has just completed three-and-a-half years with the Manhattan Project at Oak Ridge, Tennessee.

The effective life of pots for melting and casting light metal alloys, such as aluminium and magnesium, has been lengthened from four or five days to several weeks by coating them with porcelain enamel, according to the American journal, *Ceramic Forum*.

Obituary

MR. BENJAMIN COX BAIRD (for over 50 years with the Manchester Chemical Co., Ltd.) died at a Manchester nursing home on January 18.

SIR JOHN SMITH FLETT, K.B.E., F.R.S., a former director of the Geological Survey of Great Britain, died at Ashden, Essex, on January 26, aged 77. He was born at Kirkwall, Orkney, in 1869. After a brilliant career at Edinburgh University where he gained many scholarships and prizes, he acted as assistant to Professor James Geikie. He joined the Geological Survey in 1901, becoming Director in 1920. Resigning in 1935 he spent the next two years writing an account of the survey during its 100 years' existance.

MR. ALEXANDER GREIG FLEMING, a prominent Canadian engineer and chemist, has died in Montreal, aged 64. He had been chief chemist for the Canada Cement Co., Ltd., at Montreal, since 1913. Few Canadian scientists have been more widely known in Canada, the United States and South America. Possibly his outstanding research work was in connection with the deterioration of concrete in alkali soils. In 1932 he developed a special cement, Kalicrete, which has been of great value to the construction industry. In addition to his activities on committee of the Engineering Institute of Canada, he had an important part in the organisation of the Chemical Societies in Canada. He was consulting chemist of the Companhia Brasileira de Cimento Portland Perus at Sao Bralo, Brazil.

Tragedy of "Brilliant Chemist"

The tragedy of a man described as a brilliant chemist when, as a young man, he was employed at the Pilkington-Sullivan works of I.C.I. at Widnes was revealed at the inquest at Widnes on Percy Hunter Unsworth (46), of no fixed abode. The body was found in an air raid shelter; and a verdict was returned that death was due to starvation, probably accelerated by the extreme cold. Evidence was that, since a breakdown in health some 16 years ago, Unsworth had led a tramp-like existance.

The use of DDT and other recently developed insecticides is to be investigated by Glasgow Corporation in Glasgow houses and hospitals, to ascertain the value of the types, in clearing pests from such buildings. This decision follows a survey, in which the M.O.H. reported on the need to study DDT and other materials in local conditions.

Home News Items

A North-East branch of the National Brass Foundry Association is to be formed, with Mr. G. J. Shaffer, South Shields, as chairman, as the result of a recent meeting at Newcastle.

After 23 years at 36 Kingsway, the Central Office and office of the British National Committee of the World Power Conference have moved to more commodious premises at 201-2, Grand Buildings, Trafalgar Square, London, W.C.2. (Telephone, Whitehall 3966).

Provisions for the use of a Board of Appeal are the principal innovation in the new Rules of Arbitration which the British Chemical and Dyestuffs Traders' Association approved at its last annual general meeting, and which are now in force. The purpose of the Board is to obviate litigation, sometimes long and costly, in the event of disagreement with the arbitrators' decision.

Extensions to Sheffield University, at an estimated cost of £6,000,000, and aiming at providing for four times the number of prewar students, are proposed, including a new foundry and other extensions to the Departments of Metallurgy and Engineering. The University Development Campaign has already received donations amounting to £52,849, including £5000 from Thos. W. Ward, Ltd.

A new insecticide is being tested in Britain and other countries. This is hexaethyl tetraphosphate, a formula used by Germany during the war which has come into our hands as a result of the B.I.O.S. reports. It is a synthetic product and is claimed to be effective against green fly and other pests: it can be used in place of nicotine and is less poisonous. A liquid, it may become a partner with DDT, with which it could be mixed.

In recognition of his heroism when he rescued a youth from the crane in which he was trapped after a charge mixer exploded at the works of High Speed Alloys, Ltd., Widnes (THE CHEMICAL AGE, November 30, 1947, p. 683), Mr. Wilfred Beasley, process charge hand, has received a medal and certificate from Liverpool Shipwreck and Humane Society, the Order of Industrial Heroism, and a gold watch from the Board of High Speed Steel Alloys, Ltd.

Designed to attract attention to the British Industries Fair to be held in London and Birmingham, a special postmark will be used until May 16 in London and selected provincial towns, particularly those with heavy postings to overseas destinations.

The first post-war edition of the *List of National Committees and Representatives* is now obtainable from the Secretary, International Executive Council, World Power Conference, 201-2, Grand Buildings, Trafalgar Square, London, W.C.2.

Agreement to work with imported Italian labour has been reached by employees of Metropolitan-Vickers Co., Ltd., Trafford Park, Manchester. This decision to work with Italian foundrymen will affect other Manchester firms.

The probable age of the earth is 3350 million years, thinks Professor Arthur Holmes, of Edinburgh University. In a letter to *Nature*, he says he has arrived at this figure by calculations based on isotopic analysis of lead from galena and other lead minerals of known geological age.

More than half the world's new ships are being produced in British yards, where the tonnage under construction, 1,937,062, has not been exceeded since 1922, Lloyd's Register of Shipping announces. In the last quarter of 1946 in Great Britain and Ireland 33,060 tons were commenced and 267,760 tons launched.

A form of polarised window, which might in future be standardised on certain aircraft, is fitted to aircraft of the King's Flight. To exclude glare from the cabin, a window can be attached within the ordinary existing one, forming a sandwich with a dry-air space between the two sheets of transparent plastic; in the space is a sheet of polarised plastic, which reduces glare.

Mold, Flintshire, is to have a new light industry for the manufacture of chemical products which will employ about 100 men and a small number of women. More workers will be taken on later. A firm whose name is not yet revealed has bought the Alyn tinplate works and adjoining land, and work on reconversion will begin almost immediately.

Overseas News Items

The titanium shortage in the United States is expected to last for another two years.

Exports of nitrate from Chile in 1946 fell to 1,438,500 tons, compared with 1,621,024 tons in 1945. The decline was due to labour troubles at ports and plants.

Steel output in the United States in the week ending January 25 was the highest since the war ended—91.8 per cent of capacity.

Morocco plans to export 1·2 million tons of phosphates, 200,000 tons of iron-ore and about 100,000 tons of manganese-ore in the first half of this year.

The American Government announces that control will be retained over the importation and distribution of tin at least through the first quarter of 1947.

The first export of cement from the new Juan Soldado works of Chile, amounting to 4,000 metric tons, was made during December to Buenaventura (Colombia).

Causing the closure of tin dredges, gravel-pump and open-cast mines, the seriousness of the fall in Malayan coal production was stressed at a recent meeting of the Malayan Union Advisory Council at Kuala Lumpur.

The two principal nitrate plants of Pedro Valdivia and Maria Elena, it is reported from Valparaiso, Chile, will have to close down in February when 8200 workers will strike unless the management agrees to wage and other demands.

A census by the U.S. Treasury Department places the value of American assets under foreign ownership in 1941 at $12,730 million, of which some $3,200 million were British owned. Direct U.S. investments overseas in 1940 were valued at $7,000 million.

More than 12,000 metallurgists and representatives of the American metal industries met recently in Atlantic City to survey the broader use of the war-period developments in new alloys and methods in the more normal future. The congress was arranged by the American Society of Metals.

The Czechoslovak plastics industry, which has been considerably expanded during the war, is operating at about 50 per cent of capacity, chiefly as a result of the lack of intermediates which formerly came from Germany; furthermore, the industry needs new plant. Experimental work has been undertaken for the manufacture of urea.

Commercial production of food yeast is under consideration at the Industrial Development Corporation's plant in Natal.

The Canadian Steep Rock Iron Ore Mines, Ontario, producers of high grade iron ores in the Lake Superior district, reached a production record of 1,250,000 tons last year.

Holland is to import dyestuffs from Germany under contracts negotiated between British, United States and Dutch economic delegations.

Removal of all restrictions on imports of antimony, effective immediately, was announced by the Civilian Production Administration, Washington.

Owing to the rapid increase in the price of linseed, the Uruguayan Government has decided to impose a tax of 5 pesos per 100 kilos on all exports of this commodity.

Chemical and pharmaceutical products are included in a list of commodities to be supplied by Switzerland to Argentina under a new commercial agreement signed recently in Buenos Aires. Argentina will ship edible oils, raw materials and quebracho extract.

Holland has agreed to supply Denmark with chemicals, salt, pig-iron and glass under a supplementary trade agreement, valid until April 1. She will also send chemical and pharmaceutical products to Poland under a recently signed trade agreement.

The British Government's ground nut scheme to help relieve the world shortage of oils is being initiated in Tanganyika, it is reported. Officials and members of the plantation staff of the United Africa Company, which the Government has appointed to operate the scheme, are reported to have arrived in Dar-Es-Salaam.

Domestic price ceilings for copper, lead and zinc have been raised by the Canadian Prices Board in consequence of higher production costs and lower export quotas. The new prices, equal to £93 a ton for copper, £60 for lead and £57 for zinc, are still below the United Kingdom figures of £117, £70 and £70 respectively.

The value of minerals and mineral products produced in the United States and Alaska in 1946 reached a record value of 8,900,000,000 dollars, exceeding the former highest total of 1944 by six per cent. The new record is attributable to a general increase in prices and increased demand for mineral commodities. Production records were achieved in potash and phosphate rock.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

DENTON & JUTSUM, LTD., London, E., varnish manufacturers (M., 1/2/47). January 3, debenture to Martins Bank Ltd. securing all moneys due or to become due to the Bank; general charge. January 14, 1946.

JOHN BROWN & CO., LTD., Sheffield, steel manufacturers (M., 1/2/47). December 24, sub-mortgage, supplemental to trust deed dated September 29, 1944; charged on Norfolk Bar Rolling Mills, Sutherland Street and Saville Street east, Sheffield. *£514,528. August 9, 1946.

Receivership

NEWGATE CHEMICAL CO., LTD, 71 Moorgate, London, E.C.2. (R., 1/2/47). Wm. J. Watt, 20 Essex Street, W.C.2, was appointed receiver and manager on January 3, 1947, under powers contained in debenture dated August 2, 1946.

Company News

W. J. Bush and Co., Ltd., has declared an interim dividend of 4 per cent.

British Glues and Chemicals, Ltd., has declared an interim dividend of 5 per cent.

The nominal capital of **Mining & Chemical Products, Ltd.,** 376 Strand, W.C.2, has been increased beyond the registered capital of £25,000, by £25,000 in £1 shares.

The name of **Pest Protection Products, Ltd.,** insecticide manufacturers, etc., 3 Mandeville Place, London, W.1, has been changed to Mandeville Products, Ltd., as from October 15, 1946.

A profit of £11,348 for the year ending June 30, 1946, is reported by **Zinc Investments, Ltd.,** comparing with £11,294 for the previous year. Dividends totalled 5 per cent, as for the previous year.

A subsidiary company, **Broken Hill Corporation, Ltd.,** is to be formed by Zinc Corporation, Ltd., to take over the latter's interests and investments other than actual operations on its leases at Broken Hill in Australia.

A final dividend of 5 per cent plus bonus of 5 per cent (making 15 per cent less tax) is declared by **Redfern's Rubber Works, Ltd.** Final dividend for the preceding year was 6¼ per cent, plus 2 per cent bonus, making a total of 12 per cent.

The newly-formed **Bakelite Company (Canada), Ltd.,** 163 Dufferin Street, Toronto, took over as from January 1, 1947, the activities of the Bakelite Plastics Division of Carbide and Carbon Chemicals, Ltd., of the same address. Management and personnel of the company remain unchanged.

The nominal capital of **D. McDermott (Insecticides), Ltd.,** manufacturers of and dealers in disinfectant preparations, etc., 47a Church Street, Runcorn, has been increased beyond the registered capital of £2,000 by £6,000 in 5,950 preference shares of £1 and 500 ordinary shares of 2s.

Production for the year was 237,840 tons, compared with 267,658 tons for the previous year, it was reported at the annual meeting on December 31 of **Anglo-Ecuadorian Oilfields Ltd.** Owing to this decline and to an all-round rise in costs, net profit was lower, but a dividend of 7½ per cent was recommended.

Trade expansion in both home and foreign markets was referred to by Lord Aberconway, chairman, at the annual meeting of **English Clays Lovering Pochin and Co., Ltd.** There had been exceptional demand not only from large consumers but also for a variety of uses such as the manufacture of paint, refractories rubber (THE CHEMICAL AGE, January 11, 1947, p. 106.) Accounts showed that profits had substantially increased.

Chemical and Allied Stocks and Shares

REPORTS of the cumulative effects of fuel shortages have dominated stock markets. Business has been on a reduced scale, with values generally lower on balance an uncertain tendency ruling in most sections.

British Funds, however, displayed firmness and there were moderate gains among home railway prior charges, though electric supply shares again encountered a good deal of selling and prices remained below the "take-over" levels. Iron and steels receded further on the coal shortage news; textiles moved moderately lower for a similar reason; but colliery shares were firm generally on break up value estimates; and for a similar reason Cable & Wireless held all but a small part of their recent advance.

As was to be expected, shares of chemical and kindred companies have not been

immune from the general tendency. The more active shares were most affected, Imperial Chemical, for instance, moving back to 45s. 4½d., while Turner & Newall were 91s. 6d. Joseph Nathan at £19⅜ lost part of their recent big advance, while British Drug Houses receded to 61s. 3d., and B. Laporte to 102s. 6d. Lever & Unilever have been steady at 53s. 6d. Dividend on the latter has been limited to 5 per cent for some years, but it is generally assumed that sooner or later the pre-war 10 per cent rate will be restored. Wall Paper Manufacturers deferred units at 52s. 6d. have been in request. This is another instance where current dividends are below pre-war, but it is generally expected that in due course the latter rate will be regained. Metal Box shares showed firmness at £5¾. This is a case where considerable benefit may be derived from the new basis of Dominion income tax relief. British Oxygen may also benefit from this, but at £5 the price of the shares has moved back further in accordance with the general tendency ruling earlier in the week. British Match eased to 52s. 6d., while Dunlop Rubber lost ground but at 73s. showed some recovery. Paint shares have been favoured, with International Paint good at £7 13/16 on higher dividend hopes; but in other directions, Goodlass Wall at 33s. 3d. eased, and Nairn & Greenwich at 86s. 3d. reflected profit-taking.

Dealings started around 10s. 10½d. in United Steel new 4½ per cent preference, which are at present 10s. paid. Dorman Long have eased to 26s. 6d.; Guest Keen to 47s.; Colvilles to 24s. 1½d.; but, elsewhere, Powell Duffryn at 25s. 9d. strengthened slightly in the colliery section. Tube Investments at £7, and Stewarts & Lloyds 59s., also rallied slightly. Various other iron and steels were inclined to attract renewed attention on yield consideration, there being general expectations that dividend payments are likely to be maintained. Moreover, Babcock & Wilcox recovered moderately to 70s., it being pointed out that dividend estimates range up to 15 per cent (compared with the previous year's 12½ per cent) and that the interim payment has already been stepped up from 4 per cent to 5 per cent. In other directions, Associated Cement rallied to 66s., but British Plaster Board remained easier at 32s. Imperial Smelting showed steadiness at 21s. 1½d. General Refractories were 22s. 6d., but Amalgamated Metal lost ground at 20s. In response to the commencement of interim dividends with a 5 per cent payment, British Glues & Chemicals 4s. ordinary rose to 18s. 1½d.

Boots Drug improved moderately to 65s. 9d.; Beechams deferred were 27s. 6d.; and Timothy Whites, 50s; but Sangers at 37s. became easier despite the unchanged interim payment. United Molasses 55s. 9d., and Distillers 135s. 6d., moved lower in accordance with the general tendency. Leading oil shares made headway on talk of further agreements regarding Middle East oil, but prices later reacted. Shell, after rising to £5½, eased to £5 1/16.

British Chemical Prices

Market Reports

SUPPLY problems continue to dominate the industrial chemicals market and the immediate outlook, in view of the fuel position, is far from reassuring. A sustained demand is reported from all sections of the market and new business is being placed for unspecified delivery dates. The call for export shows no signs of falling off but the availability of supplies for shipment is becoming increasingly difficult. Values on the whole remain unchanged at recent levels, but adjustments, where they have occurred, have been upward. Dibasic and tribasic phosphate of soda are dearer at £27 10s. and £30 per ton respectively. A good trade in pitch and a scarcity of naphthalene supplies are the main features in the coal-tar products market, where the undertone remains strong.

MANCHESTER.—Inquiries, both from home users and from shippers, have again been numerous on the Manchester chemical market during the past week, but because of the tightening of the supply situation in a growing number of products, it has not always been possible to arrange actual business. The fuel shortage is having a two-way effect and is reacting not only on the chemical manufacturing industry itself but also on the textile trades and other leading industrial consumers. Pronounced firmness continues throughout the market. There has been little change on the week in the position of the tar products. A moderate amount of new business has been reported here, with deliveries into actual consumption going forward steadily in pitch, crude tar, creosote oil, and carbolic acid, as well as in most of the light distillates.

GLASGOW.—Business in the Scottish heavy chemical market has been as active as ever during the past week, but the general situation is extremely confused owing to cuts in supplies because of fuel shortage and changes in prices. The very heavy demand for all alkalis, calcium chloride and raw materials generally is not being met owing to manufacturers' difficulties. Prices in all sections show an upward trend and no immediate improvement can be looked for. In the export market there has been no outstanding feature. The usual steady volume of inquiries and orders has been received. Prices here continue firm and supplies are slow.

Patents in the Chemical Industry

The following information is prepared from the Official Patents Journal. Printed copies of specifications accepted may be obtained from the Patent Office, Southampton Buildings, London, W.C.2., at 1s. each. Numbers given under "Applications for Patents" are for reference in all correspondence up to acceptance of the complete specification.

Applications for Patents

Moisture dispersing apparatus.—J. Christen. 36500-1.

Amines.—Ciba, Ltd. 36576-7.

Hydrazine compounds. — Ciba, Ltd. 36717-8.

Oxidation of aluminium alloys.—Compagnie de Produits Chimiques et Electrométallurgiques Alais, Froges, et Camargue. 36595.

Condensation polymers.—Courtaulds, Ltd., and G. S. Hartley. 36428.

Artificial filaments.—Courtaulds, Ltd., and A. F. Millidge. 36974.

Penicillin.—Distillers Co., Ltd., A. V. Brancker, P. Eaglesfield, and H. Tozer. 36552.

Streptomycin solutions.—Distillers Co., Ltd., P. D. Coppock, and A. G. White. 36560.

Separation of histamine from streptomycin.—Distillers Co., Ltd., P. D. Coppock, T. Henshall, G. R. Primavesi, and J. F. Short. 36707.

Synthetic products.—Distillers Co., Ltd., L. Dennis, and T. W. N. Pond. 36550.

Separation of substances.—Distillers Co., Ltd., H. M. Stanley, and G. H. Twigg. 36551.

Moulding plastics.—J. M. Dixon, and E. I. Greenhill. 36810.

Polymers.—J. G. N. Drewitt, and G. F. Harding. 37035-6.

Organic chlorides.—E.I. Du Pont de Nemours & Co. 36805.

Chloroprene.—E.I. Du Pont de Nemours & Co. 37050.

Acrylonitriles.—E.I. Du Pont de Nemours & Co., and J. F. Walker. 37003.

Polyamides.—E.I. Du Pont de Nemours & Co., E. K. Bolton, and W. Kirk. 37004.

Diamines.—E.I. Du Pont de Nemours & Co., W. Kirk, R. S. Schreiber, and G. M. Whitman. 37002.

Polyamides.—E. Ellery, R. J. W. Reynolds, and I.C.I., Ltd. 36806.

Metal casting.—Foundry Services, Ltd. and E. Weiss. 36883.

Surface coatings.—R. P. Fraser, and A. L. Cianchi. 37078-80.

Aromatic compounds.—J. R. Geigy A.G. 36524.

Dyestuff images.—General Aniline & Film Corporation. 36617.

Dye intermediates.—General Aniline & Film Corportion. 37038.

Dyestuffs.—N.V. Gevaert Photo-Producten, A. E. van Doemael, and T. H. Ghys. 36813.

Azo pigments.—J. Glassman, D. T. Sarfas, and I.C.I., Ltd. 36544.

1 : 4-Dicyanobutene.—H. P. W. Huggill, R. G. A. New, and I.C.I., Ltd. 36807.

Metal production.—Husquarna Vapenfabriks A/B. 36866.

Nitrogen dioxide.—I.C.I., Ltd. (E.I. Du Pont de Nemours & Co.) 36804.

Ferrous metals.—H. W. K. Jennings (H. A. Brassert & Co.) 37028.

Treatment of latex.—G. Lacour. 36415.

Bearings.—Mallory Metallurgical Products, Ltd. 36448-9.

Chemical compounds.—Merck & Co., Inc. 36510-12, 36880-1.

Amino acids.—Merck & Co., Inc. 36959.

Cement compositions.—Minnesota Mining & Manufacturing Co. 36829.

Complete Specifications Open to Public Inspection

Manufacturing a citrate soluble phosphatic compound, useful as a fertiliser ingredient.—De Directie Van de Staatsmijnen in Limburg. June 12, 1945. 32788/46.

Production of high vacua.—Dow Chemical Co. June 13, 1945. 16386/46.

Organic compounds containing halogen.—E.I. Du Pont de Nemours & Co. Feb. 22, 1944. 4455/45.

Thermosetting compositions.—E.I. Du Pont de Nemours & Co. June 13, 1945. 17919/46.

Iron base alloys.—Electro Metallurgical Co. June 13, 1945. 17851-2/46.

Dyeing synthetic linear polyamide fibres.—J. R. Geigy A.G. June 11, 1945. 17383/46.

Treatment of holoacrylic resins.—General Aniline & Film Corporation. June 12, 1945. 15632/46.

Rhodacyanine dyes.—General Aniline & Film Corporation. June 12, 1945. 15634/46.

Emulsions of polymeric organic polysulphides.—B. F. Goodrich Co. June 13, 1945. 15533-4/46.

Ferrous alloys for high temperature use.—Haynes Stellite Co. June 13, 1945. 17841,2,5,6,7,8/46.

Cracking hydrocarbons.—Hercules Powder Co. Feb. 6, 1945. 34324-5/46.

Ethylenediomines.—I.C.I., Ltd. June 10, 1944. 14527/45.

Guanidine derivatives.—Lederle Laboratories, Inc. June 14, 1945. 17066/46.

Chemical process.—Merck & Co., Inc., June 15, 1945. 16397/46.

Flow or delivery fluid meter.—F. Meyer. June 15, 1945. 17001/46.

Macro molecular azo compounds.—Norsk Hydro-Elektrisk Kavaelstof A/S. June 15, 1945. 17816/46.

Itaconic acid.—Pfizer & Co. Nov. 25, 1942. 19577/43.

Catalytic polymerisation of olefins.—Phillips Petroleum Co. June 15, 1945. 17405/46.

Composite mineral and metallic product and method of producing same.—H. O. Ross. June 15, 1945. 273/46.

Processes for manufacturing mercaptans and the products thereof.—Sharples Chemicals inc. Sept. 19, 1942. 17685-6/43.

Unsaturated organic sulphur compounds.—Shell Development Co. Oct. 3, 1944. 19552/45.

Obtaining a product that may be used for causing rubber to adhere to another material.—Soc. Auxiliaire de L'Institut Français du Caoutchouc. June 14, 1945. 35083/45.

Refractory steel resisting high temperatures, chiefly for gas turbines.—Soc Rateau June 15, 1945. 14686/46.

Ethyl benzene.—Standard Oil Development Co. July 12, 1941. 22877/44.

Alkylation of aromatic hydrocarbons.—Standard Oil Development Co. July 12, 1941. 22878/44.

Hydrogenation of dimeric alpha-methyl para-methyl styrene.—Standard Telephones & Cables, Ltd. June 11, 1945. 17259/46.

Vapour generating devices and methods.—Steam Torch Corporation. June 13, 1945. 17670/46.

Complete Specifications Accepted

Phenolic-aldehyde resinous compositions.—Cellomold, Ltd., D. N. Davies, and S. R. Badley. May 11, 1944. 583,236.

Method of preparing organic disulphides.—R. H. Cooper, and Monsanto Chemical Co. Oct. 12, 1944. 583,159.

Mepacrine derivatives.—W. A. Cowdrey, A. G. Murray, and I.C.I., Ltd. June 16, 1943. 583,220.

Manufacture of oxazolone compounds.—J. S. H. Davies, W. G. M. Jones, and I.C.I., Ltd. June 5, 1944. 583,190.

Process for the production of resinous products.—E.I. Du Pont de Nemours & Co. Aug. 6, 1942. 583,174.

Manufacture of polymerisation products of ethylene.—E.I. Du Pont de Nemours & Co. Jan. 1, 1943. 583,181.

Process for the polymerisation of 6-membered cyclic formals.—E.I. Du Pont de Nemours & Co. Oct. 21, 1942. 583,225.

Production of *N*-substituted fluoroacetamides.—E.I. Du Pont de Nemours & Co. April 28, 1943. 583,264.

Resinous compositions comprising copolymers of vinyl chloride and a fumaric ester.—E.I. Du Pont de Nemours & Co. Oct. 14, 1943. 583,290.

Polymerisation and interpolymerisation of ethylene.—J. S. A. Forsyth, and I.C.I., Ltd. Nov. 3, 1943. 583,178.

Production of activated carbon.—O. Heller. March 4, and Oct. 30, 1941. 583,113-4.

Adhesionally bonding by synthetic resins.—High Duty Alloys, Ltd., and L. Whitby. Oct. 10, 1944. 583,148.

Production of high-molecular weight organic compounds containing sulphonic groups.—I.C.I., Ltd. May 22, 1942. 583,118.

Manufacture of polymers containing oxygen.—I.C.I., Ltd. July 4, 1942. 583,172.

Alkyd resins.—I.C.I., Ltd. July 28, 1943. 583,268.

Flame-treatment of ferrous metals.—J. Kershaw, Sen., J. Kershaw, Jun., and L. W. Kershaw. Oct. 16, 1944. 583,287.

Process for the preparation of hydroxylated derivatives of 8, 8-diphenyl-*n*-hexane.—Laboratoires Français de Chimiotherapie, A. Girard, and G. Sandulesco. Feb. 8, 1939. 583,209.

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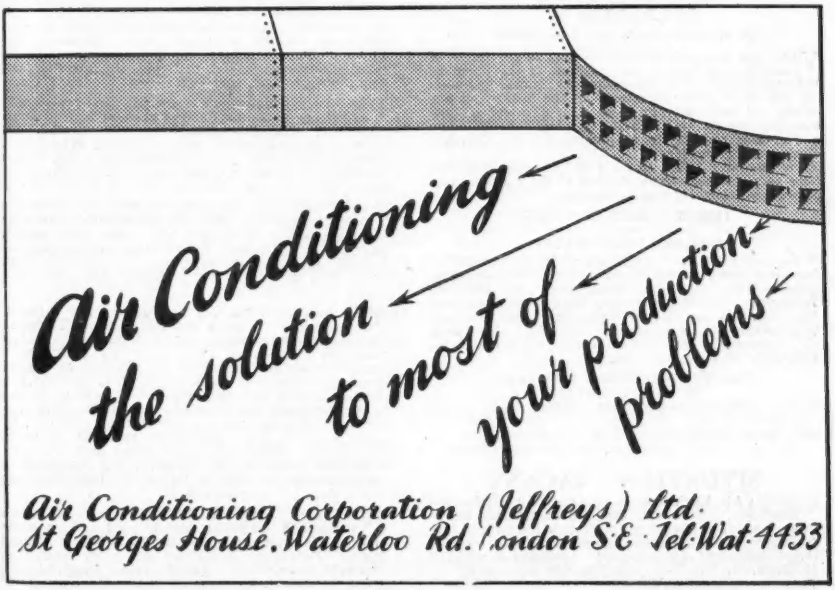

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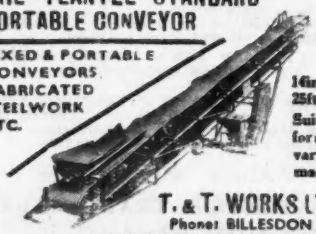

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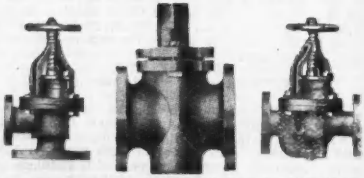

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